Table of Contents

Figures

Tables

Appendix

1 Introduction

This section will introduce the history behind climate changes and how this has lead to the invention of Green IT that can be seen as one solution to this concern. The problem that is the basis for this thesis is presented in section 1.2, along with the purpose and research question. The perspective of the thesis is also discussed, as well as the definitions for key terms, in this thesis, are given.

1.1 Background

Before the agricultural revolution, 10 000 years ago, people believed that humans should disturb the biosphere as little as possible and therefore changed their lifestyle accordingly. However, from the agricultural revolution and onward, the human population started to exploit nature and its resources in a whole new way, thereby adjusting nature to human needs instead (Milbrath, 1984). After the agricultural revolution came the industrial revolution that involved machines and inorganic material, producing goods for the growing population (Penna, 2010). These transformations and revolutions led to more power being available and increased consumption of it, thus leading to one of the three basic causes for the climate change according to scientists: fossil fuel emissions. This is a contributing reason for rising temperatures, with the other two causes being "exchange of energy by the oceans and atmosphere... and solar energy" (Penna, 2010, p. 287).

During the seventies, in the United States, people were becoming more aware of environmental issues and problems like resource conservation and water and air pollution were receiving more attention (Dunlap, Van Liere, Mertig, & Jones, 2000). At the first World Climate Conference, held in 1988, a warning of the dangers of global warning was issued and a turning point in climate policies was the United Nations Framework Convention on Climate Change in 1994. The goal at this convention was to stabilize greenhouse gases, at 1990 levels, by the end of the decade (Behringer, 2007). In the year of 1997, the Kyoto-protocol was adopted as a link to the United Nations Framework Convention on Climate Change. The protocol bound thirty-seven industrialized countries and the European community to reduce their greenhouse gas emissions by an average of 5% against the 1990 levels between the years of 2008-2012. (United Nations Framework Convention on Climate Change, 2012). The results are yet to be published.

1.1.1 Green IT

Information technology (IT) is today a widespread culture throughout any organization, consuming a lot of resources and producing waste (Brown, DeHayes, Hoffer, Martin, & Perkins, 2009; Kristiansson, 2008). IT is defined by several authors, such as Brown et al. (2009), and Pearlson and Saunders (2009), as technology used to create, process and store information, as well as aiding information communication between users.

Kristiansson (2008) stated that global IT usage consumes more power than all sectors in the Scandinavian region. Therefore, she continues to argue that by changing the way in which IT is used daily, for example by utilizing resources in a responsible way, as well as having good recycling and IT destruction techniques, the organization can reduce its waste and eliminate unnecessary energy usage, a process known as Green IT.

Past research, conducted within the Swedish environment, on the field of Green IT is limited, however, covers vital aspects of the topic. As will be discussed below, some research covers the examination and definition of what Green IT amounts to in a single Swedish company as well as in the Swedish environment. Other research examined why Green IT is

of importance for Swedish companies and investigated how to implement and further improve Green IT practices in Swedish companies.

Two separate authors of previous work, Norström (2009) and Kristiansson (2008), both investigated the effect a single Swedish company has on the environment due to its operations. They provided guidelines for improvements for their respective companies and Kristiansson (2008) argued that her thesis work could be used as guidelines for the company's future implementation of Green IT.

Broberg (2009) investigated what factors are vital, or of key importance, when choosing to adopt Green IT into an organization. His conclusions were that it is important to not examine a single factor and evaluate its potential alone. Companies should instead look at the combination of factors for choosing Green IT, and evaluate how these affect one another and in what ways. In addition, Broberg (2009) concluded that it is important to link Green IT initiatives with the business strategy and that the environmental policies are linked with the IT practices assigned. Continuous measurements are needed to upkeep a company's Green IT initiatives and its respective advantages (Broberg, 2009).

Aasvold and Nilsson (2010) join Broberg (2009) by having investigated why it is of importance for a company to have an environmental policy. Their findings were that organizations with an environmental policy can better communicate with their customers, as well as increase their competitiveness in their market segment. Kristiansson (2008) joined in on this statement and argued that it is valuable to have an active Green IT strategy and policy. She continues to argue that more than just Green technology is needed and in effect, a clear strategy can convince and gain support from user and the organization as a whole.

Frennesson and Gustavsson (2008) took a more specific aspect of Green IT, namely data centers, and investigated how energy savings can be done in this area through different techniques. On the contrary, Puelma, Huynh and Negasi (2008) looked at Green IT from a more general and strategic level and investigated the advantages and disadvantages of implementing Green IT into an organization.

Puelma et al. (2008) mentioned in their work that they saw, as a common trend, companies adopting new work practices, such as Green IT, but that the companies did not follow up on the success of the implementation nor evaluated its fit. The authors continued by arguing that this way of working usually leads to failed investments and consequences for the company. To solve this, they proposed for future research, the development of a clearer picture of how to align the company goals with the implementation of Green IT and also argued the need for ways to measure its success. In other words, they proposed the creation of a Balanced Scorecard for implementing Green IT (Puelma et al., 2008).

In addition to the Swedish research on Green IT, several international authors have conducted research on producing Balanced Scorecards for Green IT. Jain, Benbunan-Fich, and Mohan (2011) assessed Green IT initiatives through the Balanced Scorecard model as they saw the need to investigate how Green IT initiatives contribute to enterprise-wide sustainability performance. The authors based the model on several press releases, from various companies across the globe, that mention Green IT and included a sustainability perspective in addition to the original four perspectives of the Balanced Scorecard. The authors did not interview individual companies, neither did they go into full detail of how they adapted the Balanced Scorecard to the Green IT practices they found. In addition, Unhelkar (2011a) also mentions the possibility of creating a Green Balanced Scorecard in order to "help organizations in creating and implementing balanced Green IT strategies and their

policies" (Unhelkar, 2011a, p. 111). Unhelkar (2011a) does not actually create a Balanced Scorecard but discusses how each perspective of the Balanced Scorecard could include motives and measures for Green IT implementation.

1.2 Problem Statement

According to a Green IT index from Almega, many Swedish companies have a Green IT policy, but fail to implement and follow up on it because they do not have defined goals for the implementation (Wikberg, 2008). As mentioned previously, a Balanced Scorecard model can aid in creating clear and balanced goals for a company implementing Green IT (Jain et al., 2011; Unhelkar, 2011a). However, the authors saw that the previous Balanced Scorecards created for Green IT, either focus to generally on the global implementation of Green IT (Jain et al.), or was theoretical, but not fully developed to be used in practice (Unhelkar). In addition to this, none of the previous Balanced Scorecard models were created in regards to the culture, business and mental thinking of a Swedish company.

Thus the problem statement is that, at the present, there is no Balanced Scorecard model adapted for the implementation of Green IT in the Swedish environment. The authors see the need for a tool to help both Swedish companies, as well as other researchers, to understand what objectives are currently used in the implementation of Green IT in Sweden.

1.3 Purpose

The purpose of this thesis is to investigate if the Balanced Scorecard model has to be adapted and can be used to find objectives, through IT practices found in the Swedish environment that can aid in the implementation of Green IT.

1.4 Research Question

Can the Balanced Scorecard model be adapted and used to create objectives for the implementation of Green IT in a Swedish environment?

1.5 Perspective

The intention of this study is to research the field of Green IT from a consumer perspective. This implies that the companies interviewed are consumers of Green IT and not providers of Green IT solutions. Looking at the consumer side of the question will better fulfill the purpose of this study since the consumers of Green IT are the ones that have implemented Green IT practices.

1.6 Definitions

Below, table 1.1 is a summary of definitions that the authors have chosen to use as standards in this thesis.

Information Technology	Technology used to create, process and store information, as well as to aid in communicating information between users (Brown et al., 2009; Pearlson & Saunders 2009).
Green IT	Working to improve the phases of design, production and usage of IT hardware, software and communication systems to effectively and efficiently use IT as a tool in the business, with minimal effect on the environment and promoting sustainability (Murugesan, 2010).
Balanced Scorecard	Describes the mission and activities of an organization that are derived from the organizational strategy. These missions are seen through four different perspectives; financial, customer, internal processes, and employee learning and growth (Niven, 2007).
Sustainability	Actions that control the amount of resources used in the present, so that even the future can use the same amount of resources (Dunphy, 2011).
Green IT Practices	Within this term several practices, concepts and methods are introduced that promote Green IT and environmental awareness within IT.

Table 1.1 Key definitions

2 Frame of Reference

The Frame of Reference section presents the theoretical background for this thesis. The area of Green IT will be discussed, along with definitions, drivers for Green IT and common practices often found and considered in the implementation of Green IT. Those terms and practices introduced using italics will be used in the analysis section. In addition, the Balanced Scorecard model will be introduced.

Several authors have defined Green IT, such as Kristiansson (2008) and Lamb (2009). Kristiansson (2008) simply describes Green IT as applying environmental consciousness in the IT industry. Lamb (2009) defines it further and states that it is about utilizing IT more efficiently to reduce energy consumption and thus create an energy-efficient IT solution for the organization.

However, for this thesis, the authors have chosen to use Murugesan's (2010) definition of Green IT because it is more comprehensive. Green IT, according to Murugesan (2010), is working to improve the phases of design, production and usage of IT hardware, software and communication systems to effectively and efficiently use IT as a tool in the business, with minimal effect on the environment and promoting sustainability.

As seen in Murugesan's definition of Green IT, the topic covers a wide array of IT improvements that can be done to decrease the environmental impact of a company. Areas within Green IT include; reduction of energy consumption, energy efficient end-user devices (Kristiansson, 2008), optimizing and virtualizing data centers, better communication equipment (Unhelkar, 2011a) and responsible design, use and disposal of IT products (Murugesan, 2010). These are a few examples of Green IT practices that will be discussed in greater detail in this section.

2.1 Drivers of Green IT

Many have stated that reducing greenhouse gas emissions for an organization will be an expensive process. However, during the last years, companies have significantly managed to reduced their carbon footprint and still been able to make a profit (Gore, 2006; Nidumolu, Prahalad, & Rangaswami, 2009). What is interesting in this statement is that even though companies find Green IT challenging and expensive, they still go through with the implementation of it. The six drivers (see Figure 2.1) discussed below may be the motivation behind the implementation of Green IT practices.

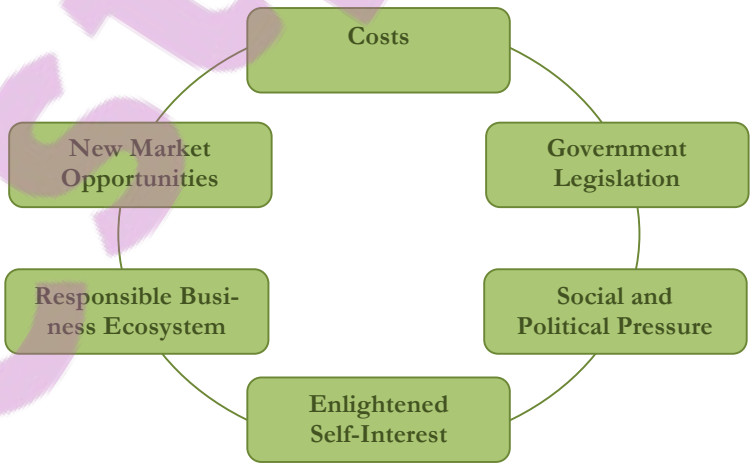

Figure 2.1 Drivers of Green IT (Unhelkar, 2011a)

The *Costs driver* pushes Green IT projects to be managed efficiently, ensuring that the most amount of costs are eliminated and that money is saved. Through Green IT implementation, the organization has the possibility to optimize its processes to reduce unnecessary and costly steps (Unhelkar, 2011a), as well as reduce the amount of resources put into the process (Nidumolu et al., 2009). They can also reduce the number of physical machines, which both takes up space and uses a lot of energy (Unhelkar, 2011a). Murugesan (2008) promotes using virtualization techniques in data centers to reduce equipment costs and size.

However, it needs to be mentioned that there is a risk of miscalculating the cost of the new technology that is replacing the old. For example, if stationary computers are being removed from an organization to save money and space, mobile devices that in turn may increase operations cost in the long run might replace them. Therefore, it is important to evaluate the new costs with the old costs, as well as compare this difference with the amount of carbon reduction that could be done achieved (Unhelkar, 2011a).

Increased *Government Legislation* on environmental issues has put greater force on organizations to improve and eliminate their carbon emissions (Murugesan, 2010; Unhelkar, 2011a). Some governments, such as the Australian government, are forcing companies to report their carbon emission annually if it is above 150 kiloton. This driver is a heavy weight for any organization as it comes from authorities and must be complied with. With the implementation of Green IT, carbon reduction can be easily assessed and also done through several means (Unhelkar, 2011a). A Swedish government legislation (see p. 13 in the thesis) controls how Swedish companies run their business and demands that the business is run in a sustainable way. Further discussion on Sustainability as a driver of Green IT is done below.

The *Social and Political Pressures* driver only come into play depending on the type of society the organization acts and operates in. If the society sees the environment as a major actor in the value system, the organization feels pressured to do something about their carbon emission and use of environmental resources (Unhelkar, 2011a). When making buying decisions, today's customers have now started to take the suppliers' environmental records and initiatives into account, giving the green organization a competitive advantage (Murugesan, 2008). An example of this type of pressure is the increasingly popular Earth Hour, taking place every year since 2007, on the last Saturday in March. Started by the World Wildlife Foundation (WWF) in Australia, its main aim to prove that everyone, including children and CEOs, could do something to change the world (Earth Hour, 2012a). This pressure has now spread worldwide and in 2012 more than 150 countries and territories participated in the event (Earth Hour, 2012b).

The *Enlightened Self-Interest* driver occurs when the company themselves find a need to become more environmentally friendly. This need may come from the organization wanting to do a common good, personal satisfaction from top management (Unhelkar, 2011a), or for competitive reasons to look better for the end customer as compared to competitors (Lamb, 2009).

Collaborations with other, both larger and smaller companies, can cause pressure in becoming more environmentally friendly, due to *Responsible Business Ecosystems*. When one company decides upon improving its processes and services to reduce carbon consumption and nonrenewable resources, they put pressure on both their suppliers and consumers to improve their own processes in turn (Unhelkar, 2011a). This will involve collaboration between trading partners and better consumer-supplier relations. With new technology, better

power management policies will be set that can act both on the supplier and on the consumer network (Unhelkar, 2011b). However, Unhelkar (2011b) also argues that trust and security issues will arise from this tighter collaboration between partners, but may be resolved by the growing use of cloud computing.

Green strategies are an emerging trend and are therefore a new way to compete on the market. As with any *New Market Opportunity*, there are a multitude of possibilities in which to compete, but as always, this requires the company to be the best in the industry. Therefore, in accordance with Green IT possibilities, the company's strategies need to be formed in such a way that they outrival the competitors and that the company stands out as a forerunner in the market (Unhelkar, 2011a). For example, Green IT can help a company become more mobile by implementing cloud computing and IT virtualization (Lamb, 2009) that are Green IT solutions removing the need for large physical storage units (Unhelkar, 2011a).

In addition to Unhelkar's (2011a) six drivers of Green IT, Nidumolu et al. (2009) argue that *Sustainability* can also be seen as an optional driver of Green IT. Sustainability is, according to Dunphy (2011), actions that control the amount of resources used in the present, so that even the future can use the same amount of products. Also, a sustainable organization is one that actively works at removing all destructive effects from their business on the earth, contributing to current and future generations well being (Dunphy, 2011). Nidumolu et al. (2009) lists five steps in creating a sustainable organization: view compliance as an opportunity, making value chains sustainable, designing sustainable products and services, developing new business models and creating next-practice platforms. They argue that the initial driver of implementing Green IT is often to improve the company's image, but that the implementation usually also results in cost reductions and new market opportunities.

2.2 Green IT Practices

According to Unhelkar (2011a), a Green Organization has three major areas in which it can influence both the way they conduct their business, as well as how their consumers and suppliers perform and run theirs; Green Processes, Green Data Center and Green Consortiums. This model, shown below in figure 2.2, provides a practical way of categorizing the different practices within Green IT, and it is therefore used to easily present several different Green IT practices discussed in the literature.

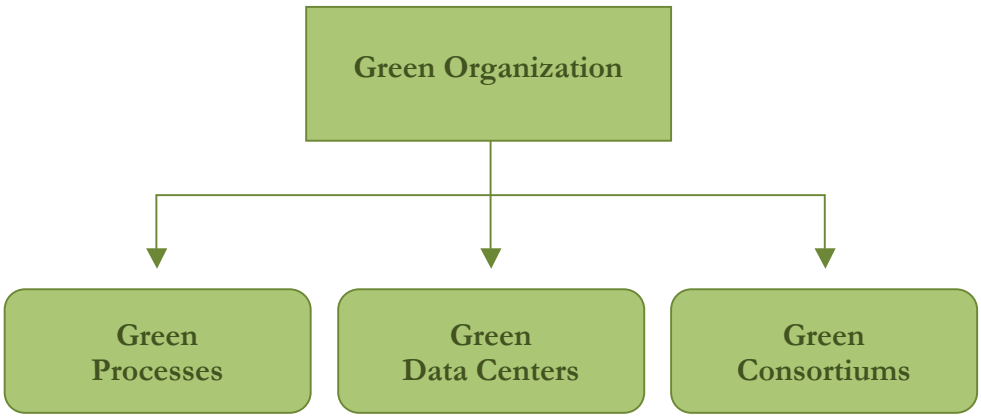

Figure 2.2 Major Areas of Influence of the Green Organization (Unhelkar, 2011a)

2.2.1 Green Processes

Green Processes are operations and activities that an organization performs, focusing on Green thinking and environmental consciousness. These Green Processes have usually been reengineered from older ones to reduce the company's environmental impact and CO_2 emissions. They can include both internal and external activities and can be meant to provide benchmarks and lead-by-examples to help others near the organization to follow their lead (Unhelkar, 2011a).

A device goes through three major phases in the IT asset lifecycle; Procurement, Operation and Disposal (Unhelkar, 2011a). A good beginning, or procurement, of an IT asset both assure the environmental responsibility of the asset, as well as it aids for the future phases of the IT asset's lifecycle. According to Unhelkar (2011a), end-user devices are one of the major IT products that affects the environment and he continues to state, along with Kristiansson (2008) and HP (2011), that it is important to focus on buying low-powered devices and choosing the most environmentally friendly ones to make up for some of the negative effects. In addition, the device should be manufactured in biodegradable material, and should easily be *recycled* (HP, 2011; Unhelkar, 2011a). Murugesan (2008) agrees with this statement of selecting and *evaluating suppliers*, and argues that a trend is that companies are taking it to the next level, demanding from their suppliers to actively become more environmentally friendly in the way of doing business. HP (2011) recommends to only to buy from environmentally friendly vendors.

To assure that the procured items are environmentally built, companies can opt to choose products that are *eco-labeled*. There are several types of IT eco-labels, such as Energy STAR, TCO (HP, 2011; Unhelkar, 2011a) and Svanen that is the Nordic region's official alternative to eco-labeling (Miljömärkning Sverige AB, 2012). These will be discussed in more depth in the Green Consortium section further down.

By changing the way in which employees operate and interact with their end-user devices, a considerable reduction in the company's energy consumption would be possible. *Turning off a single computer* might not seem profitable, but considering the hundreds, maybe thousands, of desktop computers that are used in a company, the savings could be substantial (Murugesan, 2008; Unhelkar, 2011b). Also, by introducing *communication technology*, such as web and phone conferences, traveling resources and emissions can be reduced (Unhelkar, 2011a).

One way of reducing the energy consumption of desktop computers, or any other end-user device is to install a sleep mode. A technique that can be used for this is to install a software that provides network-level control over PCs and monitors, and shuts down, or puts each computer into standby or hibernation mode, without harming the performance (Unhelkar, 2011b; Murugesan, 2008). The network manager can then, through the software, remotely control the power-up or power-down of the computers when, for example, backups are being made (Murugesan, 2008). According to the US Environmental Protection Agency (EPA), sleep mode on a computer can save 60-70% of energy and thus "reduce carbon... emission by the equivalent of 5 million cars." (cited Unhelkar, 2011a, p. 90).

In addition, by using *thin-client* computers, each PC will only use a fifth of the power of a normal desktop PC (Murugesan, 2008). However, this gain needs to be weighed out with the energy to support the greater bandwidth needed, as well as the need for increased cooling for the servers in the data centers (Unhelkar, 2011a).

When reengineering end-user device usage, the organization can aid the user to make the right decisions when printing out papers. By making two-sided, gray-scaled *printing default* (Unhelkar, 2011a; Unhelkar 2011b), the user actively has to choose if more resources, such as paper and ink, are needed for their printing needs. In addition, limits on papers printed per day could be set and a centralized help desk for printing documents could be opened to better control the usage (Kristiansson, 2008; Unhelkar, 2011a). Taking care of recycling paper and old toners is also part of better printing techniques (Unhelkar, 2011b)

When an IT assets' life cycle ends, it becomes electronic waste (e-waste) (Tomlinson, 2010), and the components should be recycled to reduce the total impact the product lifecycle has on the environment (HP, 2011; Murugesan, 2008; Unhelkar, 2011a). However, the device's components may not, for whatever reason, be recyclable and the public environment often blames the organization for not being able to dispose of the device in an environmentally friendly way. This consequence may not be the organization's fault as the computer might have been designed in such a way that is not possible to recycle any component (Tomlinson, 2010), however, the organization still has some responsibility in the matter as it can choose to buy eco-labeled products (Unhelkar, 2011a).

A *renewable energy source* is, according to Jönköping Energi (2012), a source of energy that can be used and will not be depleted in the foreseeable future. Unhelkar (2011a) lists six of the most common renewable energy sources available: nuclear, thermal, wind, water, solar and biomass. He continues to state that these energy sources, in addition to not depleting the Earth's resources, also can aid in the reduction of carbon emissions from the source itself - the production of the energy. Unhelkar (2011a) mentions, however, that not all regions of the world are able to provide renewable energy sources. He continues, European countries are in the lead in trials and use of renewable energy consumption. According to the Energy Administrative Authority of Sweden, during the years 2009 and 2010, 47% of all energy used in Sweden was from renewable resources. This level was not anticipated to be reached before 2015-2016, showing that the Swedish market is willing and is actively choosing energy from renewable resources (cited in Hansson, 2011).

Research has previously shown that adding, or completely replacing non-renewable energy sources, with renewable ones, can create problems for companies as renewable energy sources are not as reliable as, for example, fossil fuels. However, through smart power grids, enabled by IT, supply and demand can be regulated on a more detailed level and thereby help solve the problem (Tomlinson, 2010).

According to Tomlinson (2010), the key to success in reducing energy consumption is to monitor energy usage properly and reliably. Therefore, companies should replace their old energy meters with newer, smarter ones that can create an integrated power grid that will enable them to see where the energy is being used (Tomlinson, 2010). Unhelkar (2011a, 2011b) refers to these as *smart energy meters* and argues that they do not only measure power consumption automatically, but also provide the organization with real-time feedback of how much energy that they are consuming and on what devices. This real-time information can then be gathered for further analysis, and some smart meters, installed correctly, can even turn off devices once they have used a given amount of energy (Unhelkar, 2011a).

IBM's vice president of energy and environment has stated in Lechner (2009) that a piece of data is on average saved thirty times on different computers and servers within an organization (cited in Tomlinson, 2010). This requires a lot of space on servers, physical space, as well as it in turn causes more energy consumption. However, with the help of *Document Management Systems*, the duplication of files and folders could easily be eliminated. A Docu-

ment Management System, can either be a web-based service or an in-house server solution, and its main purpose is to control all files and folders located in the business in one place, where they easily can be viewed in their different versions and read by several users (Tomlinson, 2010).

In order for all of these Green IT processes and practices mentioned above to be able to achieve and contribute to a greener organization, awareness among the employees is needed to be raised, through *Green IT education* (Nidumolu et al., 2009; Unhelkar, 2011b). All organizations with active Green IT practices, need to seek their employees satisfaction for a certain practice, as well as listen to and handle their concerns. It is also vital to teach them how to work with their new tasks, as well as encourage them to come up with new, greener solutions (Murugesan, 2008). Murugesan (2010) states that IT professionals and students need to be educated in the subject in order to increase the understanding of Green IT, which can be done through courses at universities and learning institutes.

By using tools such as "web portals, blogs, wikis, and interactive simulations" (Murugesan, 2008, p. 33) green awareness could be spread among IT professionals, employees, businesses and also the general public. Education and knowledge of how to become green, and how to use Green IT process, is needed to help create awareness of how IT could be a contributing factor to a more environmentally friendly way of doing business for an organization (Murugesan, 2008).

2.2.2 Green Data Centers

Another major IT area that influences the environment, is the multitudes of data center servers that are needed in the business, both the real servers and the backups. In this area, Green IT should be used to optimize and virtualize as many data centers as possible to bring down the number of physical units used (Unhelkar, 2011a). Pearlson and Saunders (2009) provide the example of comparing the energy consumption of five of the largest search engine companies and the maximum amount of electricity produced by the Hoover Dam in Nevada, USA. The companies used about two million servers together in 2008, needing about 2.4 gigawatts of electricity to function; the Hoover Dam produced two gigawatts of electricity in total in 2008.

Data centers are a big part of an organization's hardware assets and can be built and specialized to become a Green IT asset. Data centers are secure and protected environments, in which servers are stored, with large amounts of data for the organization. Data centers can be seen as the 'heart' of most businesses. Along with the servers necessary, network connections are in place, as well as the critical cooling units and back-up power, also known as *Uninterruptible Power Supply* (UPS) (Unhelkar, 2011a). The benefits that come from making data center improvements could be tax incentives and also a competitive advantage because more customers are demanding greener services (Murugesan, 2008).

To create a green data center, the physical building in which the center is housed plays a large role in how environmentally friendly the data center is. The data center can be located within a building or within several, either located in one region, or spread out across different countries. Where the building is placed, and in what region and climate, is a vital decision for managers because the buildings themselves usually remain in use for about fifteen to twenty years, whilst the equipment inside may be changed every fifth year (Unhelkar, 2011a). Murugesan (2008) agrees that the *positioning of the data center* is important and should be chosen with regards to the use of natural light, cooling and ventilation.

There are several different Green practices that can be used in data centers. *Blade servers* are one of them and are a relatively new technology where several servers share networking devices, administrative modules and fan-modules in a base frame. Older types of severs, monolithic servers and rack servers, all have their own networking, administrative and fan modules making them larger in size and more drift expensive. By instead sharing these modules, the data center becomes more energy efficient and at the same time minimizes hardware usage and physical space needed in the data center (Frennesson & Gustavsson, 2008).

Virtualization initiatives can be defined as "running multiple virtual computers on a single physical computer" (Jain et al., 2011, p. 28), which improves hardware utilization and reduces the total data center energy demand. By reducing the number of physical servers in the data center, data center floor space and building size is also decreased, as well as less employees are needed (Murugesan, 2008; Unhelkar, 2011a). Virtualization work through providing a layer between the hardware and the software allowing all operating systems to communicate with the same hardware simultaneously (also known as thin client-fat server) (Frennesson & Gustavsson, 2008), leading to better use of the computers' resources, and higher efficiency and usage of the servers (Frennesson & Gustavsson, 2008; Unhelkar, 2011b).

Cooling strategies are vital for the performance and the lifetime of components within data centers. However, cooling is not an easy task because all electrical objects within the data center emit heat radiation, including the cooling units themselves (Frennesson & Gustavsson, 2008). Nevertheless, installing a cooling system is one of the most concrete ways to adopt Green IT practices (Unhelkar, 2011a). Below, two types of cooling systems are discussed.

Free cooling is a technique in which the data center is cooled by drawing in cold outside air into the data center. This technique works best in regions where the average temperature, over a year, is low. For example, regions in the north of Sweden, such as Luleå, have an average year temperature of 1-2 degrees Celsius and are therefore suitable for free cooling in data centers (Brundin, 2011).

A popular arrangement for server racks, is to place the fronts of all servers facing the same direction in which the cool air is blowing. The fans in the servers then draw in the cool air transporting it through the entire server, whilst cooling it and emitting hot air through the back. The backs of all the servers face the exhaust fan transporting the hot air out of the data center (Unhelkar, 2011a). See figure 2.3 below.

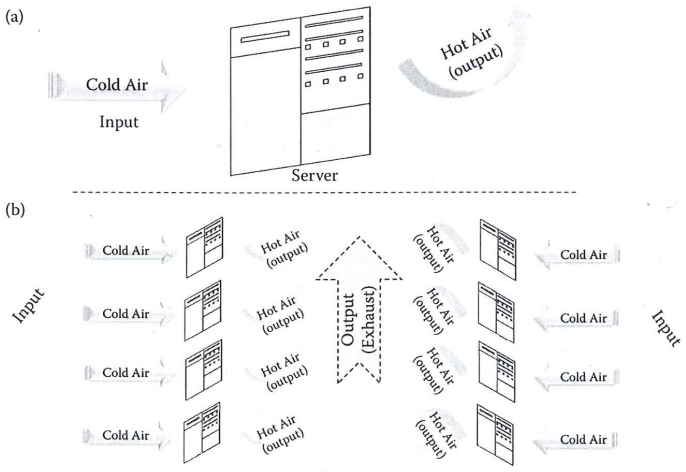

Figure 2.3 Servers in hot-aisle-cold-aisle arrangement (Unhelkar, 2011a)

PUE stands for *Power Usage Effectiveness* and can be used as a metric to make data centers more effective. If a data center has a PUE value of 1, all energy consumption is used solely for computation and the data center has therefore reached total effectiveness. However, if the value goes above 1, this indicates that energy is also used for other activities than computing, for example cooling or lights. In the current industry, a PUE of 2 is considered to be good (Tomlinson, 2010).

2.2.3 Green Consortiums

This is the section that allows organizations to lead the change. Consortiums allow organizations to join and lead the changes with already existing standards and initiatives, showing consumers that they are serious and may even invite suppliers or others in their environment to follow their lead (Unhelkar, 2011a).

Protocols are international agreements, formed by political leaders from the entire world that bind countries to certain emissions controls and carbon reduction plans. An example is the well-known Kyoto Protocol, where the main aim is to stabilize the concentration of greenhouse gases to a level that would prevent danger to the climate (Unhelkar, 2011a).

In addition to protocols, standards provide a framework for organizations to aid in environmental management and also provide a benchmark for companies to compare themselves to others, both internationally and domestic. An example is the ISO 14000:2004 family that is the most common for environmental frameworks (Unhelkar, 2011a; Unhelkar, 2011b).

The International Organization for Standardization (ISO) has created the *ISO 14001* standard to certify organizations implementing "Green IT strategies, metrics, reporting, and continuous improvements" (Unhelkar, 2011a, p. 332). This standard provides guidelines of what the company should perform, and excel at, within Green IT practices. It contains a policy defining environmental objectives that the organization has to consider, a plan of what process, technologies and user factors are required, as well as a risk assessment and product life cycle assessment. The standard also contains implementation and operating techniques, including education and training programs, and how to communicate the change. Lastly, checking and making corrective actions, and management review techniques are available for the organization (Unhelkar, 2011a).

Initiatives are an additional consortium that includes personal, industrial, or government actions driven by, in many cases, self-interest in the area. These initiatives, for example industrial ones, such as Energy STAR and TCO, not only aid the industry, but also allow other organizations and private users to choose Green IT strategies and products (Unhelkar, 2011a).

Energy STAR is a voluntary initiative that labels energy efficient products to help consumers identify products built for lesser energy consumption. The initiative regulates how much external and internal power supply and consumption the device is allowed to have for different modes, such as sleep, idle and active (Murugesan, 2008). This label has, since its start in 1992, promoted energy-conscious decisions and saved billions of dollars in energy consumption reduction (Unhelkar, 2011a).

TCO Certification was launched in 1992, as an initiative in quality and environmental control for IT equipment. The initiative "covered electromagnetic fields, energy efficiency and electrical and fire safety" (Sundblad, Lind & Rudling, 2002, p. 1). The requirement have since then been adapted further to include ergonomic and ecological initiatives. TCO Certification is seen as an international de facto in initiative surrounding IT devices (Sundblad et al., 2002).

Svanen is an eco-labeling initiative from the Swedish government that promotes reduction in energy consumption, as well as to reduce the amount of hazardous chemicals used in the production of computers. Svanen places very high demands on the manufacturers of computers as they demand that the computers should be designed in such a way that they are easy to upgrade and repair whilst still in working order and when the computers are ready to be disposed of, they should easily be recycled (Miljömärkning Sverige AB, 2012).

Legislations are passed by a country's government, specifying certain requirements and legal compliances that all organizations within the country need to comply with. This enables better trade among partners and a platform from which additional Green IT strategies can stand upon (Unhelkar, 2011a). The strongest *Swedish legislation*, regarding environmental protection is the Environmental Code (Miljöbalken 1998:808) that came into effect 1998. This legislation's main aim is to promote a sustainable community development that does not compromise the present, nor the coming, generations' health and environment. The legislation controls the need to protect the environment, whilst still allowing the population the right to use and change the environment around them responsibly (Sveriges Riksdag, 2012).

In addition, the Ministry of Industry, Employment and Communication in the Swedish Government Offices have specified that the goal for IT-politics is to create a sustainable information community for all citizens of Sweden. IT should be used to promote sustainable growth through resource- and energy-efficient solutions that promote efficiency, improvement and international competitiveness (Regeringskansliet, 2012).

2.3 The Balanced Scorecard

The Balanced Scorecard model allows for an accessible and comprehensible way of describing the mission and activities of an organization (Olve & Sjöstrand, 2006). It should be derived from an organization's strategy and can be used as a tool to communicate to the users and external stakeholders, the firm's mission and strategic objectives, through outcomes and performance drivers (Niven, 2007).

Effective scorecards represents "cause and effect relationships between current activities and long-term success" (Olve & Sjöstrand, 2006, p. 1) and has several different usage areas:

Effective execution of a new strategy (Niven, 2005). The Balanced Scorecard is known for its effectiveness in helping an organization execute its strategy through its objectives, measures, targets and initiatives. However, it is important to note that the scorecard was not developed to aid companies in developing a new strategy, it was created to support companies in their progress toward executing their already existing strategy (Niven, 2005).

Discussing activities that are motivated by strategic aims rather than current necessities and how they will pay off in the future, such as development of competencies, customer relationships and IT (Olve & Sjöstrand, 2006). The creation of a Balanced Scorecard may lead the organization to reconsider their strategic objectives and thereby enable the creation of a new strategy (Niven, 2005). Olve & Sjöstrand (2006) also mentions that some organizations mainly use the Balanced Scorecard to discuss strategies and have not implemented it further.

Communicating strategic intentions (Olve & Sjöstrand, 2006). By stating desired outcomes and performance drivers (Niven, 2007), the Balanced Scorecard can help the organization achieve their long-term goals by channeling the employees' energy, knowledge and activities (Kaplan & Norton, 1996). It can also be used when priorities, and causes and effects, needs to be communicated (Olve & Sjöstrand, 2006).

Monitoring and rewarding strategic activities. The Balanced Scorecard approach can also be used as a tool to check the progress of the strategy execution and what has been achieved so far (Olve & Sjöstrand, 2006).

Developing external collaborations. As outsourcing and external partnerships are becoming more common in the present business world, the Balanced Scorecard can be used as a way of creating and maintaining lucrative relations between parties. The collaborations in supply chains, and external supplier relations, require formal and informal contracts that span longer periods than normal market relations. The purpose of these partnerships is to find joint business practices that are profitable for both parties, not to find the most cost-effective product for the individual organization (Olve, Petri, Roy & Roy, 2003).

Since the start of the modern way of doing business, executives have been using financial measures, but in today's world of changing business requirements, it is not enough. (Niven, 2007). Niven (2007) gives five reasons for why the use of financial measures has become overabundant: financial measures are not consistent with today's business realities; it only measures past performance; it tends to reinforce functional silos; it may sacrifice long-term thinking, and; financial measure are irrelevant to many levels of the business.

The Balanced Scorecard model (see Figure 2.4) was first introduced in 1992 by Kaplan and Norton, and has since then become a widely adopted approach to management control and performance management by both business and government (Niven, 2007). Kaplan and Norton (1996b) recognized that business requirements were changing and that firms' ability to capitalize on intangible assets were becoming more important than their management of tangible assets.

The Balanced Scorecard was created as a complement to financial measures, not as a substitute (Kaplan & Norton, 1996b), and worked on balancing the four perspectives in order to give a comprehensive description of the business. It not only gives information about the company's objectives from four different perspectives, it also considers the time dimension, meaning that past investments may have consequences for today's profitability (Olve & Sjöstrand, 2006).

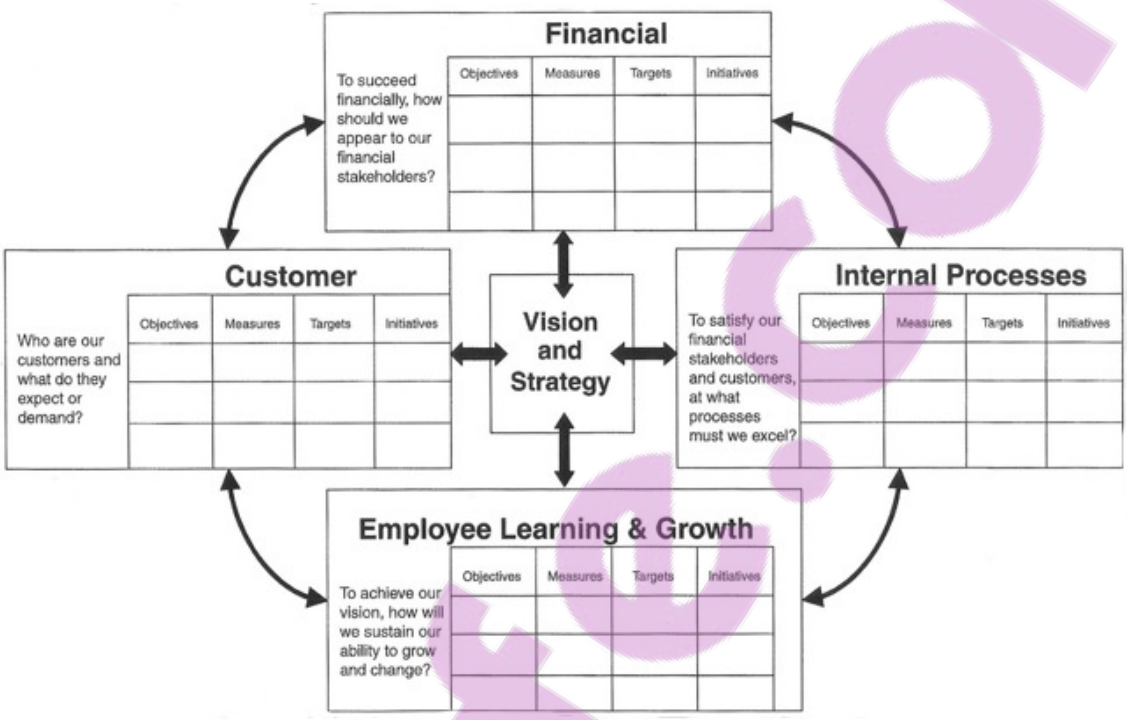

Figure 2.4 The Balanced Scorecard model (Niven, 2007)

2.3.1 The Balanced Scorecard Model

Kaplan & Norton (1996a) states that a Balanced Scorecard should be derived from an organization's unique strategy. By using the Balanced Scorecard, the strategy and vision of the company can be converted into performance measures that include both outcome measures and the drivers of these measures. For a strategy to be successful, it needs to consider financial ambitions, processes to be improved, markets served and the people in the organization that actualize the strategy (Niven, 2007). The Balanced Scorecard uses all these aspects by considering both internal and external aspects (Olve & Sjöstrand, 2006).

Every perspective should contain four different sections: objectives, measures, targets and initiatives. For employees to be able to act upon the organization's vision, translating the strategy and mission of the company into objectives is the first step in the creation of each perspective. Strategies like "an empowered organization" (Kaplan & Norton, 1996b, p. 76) is hard to realize in practice and senior executives should therefore create understandable and actionable objectives, along with defined measures to keep track of the progress of reaching each goal (Kaplan & Norton, 1996b).

Each measure should then be associated with a target (a short-term goal) that works as a milestone to assist in evaluating the progress of each objective. The last column in each perspective should be initiatives, describing actions that should be undertaken by the firm to reach each objective (Kaplan & Norton, 1996b).

In order to achieve a balance between intangible and tangible assets, Kaplan and Norton (1996a) created four different perspectives that contained financial, customer, internal processes and employee learning and growth aspects. Critical success factors, strategic goals, measures and action plans is to be created for each perspective, using the company's overall vision as a starting point (Olve & Sjöstrand, 2006).

The relationship between the different perspectives is shown through cause and effect relationships. To achieve financial profitability, the organization must satisfy their customers and become more efficient by excelling at key business processes. The customers can only be satisfied by improving business processes in such a way that they are suitable to customers' needs. Internal processes are improved by learning and developing business requirements in the future through value propositions and internal processes (Olve & Sjöstrand, 2006).

Even though intangible assets are becoming more important, financial measures are still crucial to the organization since its efforts in customer satisfaction and internal processes will not be of value unless it is shown in the firm's financial returns (Niven, 2007).

The *financial perspective* should be used to ensure that the organization is implementing and executing their strategy proposition effectively and cost-efficiently, getting a positive effect in the bottom-line results. Indicators in this perspective are usually lagging, showing past performance and includes profitability, asset utilization and revenue (Niven, 2005).

Typical financial goals consider growth, profitability and shareholder value, and 'to survive, succeed and prosper' are examples of these. To measure these financial goals, success by quarterly sales growth, increased market share by segment, return on equity and cash flow, can be used (Kaplan & Norton, 1992).

The *customer perspective* of the Balanced Scorecard forces managers to translate their, often customer-focused, mission into measures that can help to evaluate what really matters to the customers and the firm's progress in meeting those requirements (Kaplan & Norton, 1992). Niven (2007) states that the customer perspective should declare who the organization's target customers are, what they demand or expect and what the company's value proposition is towards them.

Customers' concerns often fall into different categories: quality, time, cost and performance and service. These different categories can be measured in several ways. For example, quality can be measured through on-time delivery (Kaplan & Norton, 1992) and "defect level of income products as perceived and measured by customers" (Kaplan & Norton, 1992, p. 73). The time aspect can be measured by looking at different lead-times and by measuring how the company's products or services creates customer value, performance and service can be evaluated (Kaplan & Norton, 1992). Other typical customer measures are customer satisfaction, market share, customer loyalty and customer acquisition. Like the financial perspective, the measures of the customer perspective are often lagging (Niven, 2007).

When working with the *internal processes perspective* of the Balanced Scorecard, managers should consider the processes and competencies that they need to improve in order to increase customer satisfaction and meet customers' needs. Therefore, measures in this perspective should be derived from the business processes that impact the customers the most (Kaplan & Norton, 1992). Niven (2007) states that one of the challenges to the internal perspective is to find what processes are the most important to excel at and the best way to get results is to look at the measures in the customer perspective. Managers should look at

the four categories mentioned above and, for example, if reliability is an important factor for the organization's customers, maintenance should be considered in the internal perspective and be seen as a process that the company should excel at (Niven, 2007). Examples of processes often discussed in this perspective are "product development, production, manufacturing, delivery, and post-sale service" (Niven, 2007, p. 201).

The *employee learning and growth perspective* is usually the last perspective that is developed in the creation of a Balanced Scorecard and recurring aspects to be considered are employee satisfaction and skills, and alignment and availability of information (Niven, 2007). The goals of this perspective enable the success of the others and should be designed to close the gap between the present infrastructure of the company (including organizational, informational and human capital) and the firm's desired direction of IT (Niven, 2007). The organization's ability to improve existing processes and skills, as well as introducing new products and practices, is crucial for its survival. Companies should therefore, through this perspective, make sure that it can respond to future changes in business requirements (Kaplan & Norton, 1992).

3 Method

In this section the philosophy behind this research will be discussed, along with the research approach and design that has been chosen. After that, the data collection techniques for the secondary data and empirical findings are shown and the credibility of the research will be argued for. Finally, the analysis process will be discussed in length, showing how the resulting Green IT Balanced Scorecard model was made.

3.1 Research Philosophy

Saunders, Lewis and Thornhill (2009) argue that the research philosophy of a research contains assumptions about how the authors view the world and this view should underpin the research strategy of the work. The research philosophy of this study is direct realism, as it takes the viewpoint that things exist independently of the human mind (Saunders et al., 2009). The authors believe that the Green IT practices found through the secondary data and the empirical findings, which will be discussed below, exist in spite of what the practitioners, for example the interviewees, believe and perceive Green IT to be. However, the authors realize that Green IT is a dubious concept that may result in Green IT practices being interpreted differently and thereby used differently.

3.2 Research Approach

This thesis is grounded on an inductive research approach that develops the resulting theory after data has been collected (Saunders et al., 2009). The thesis work started with a data collection period, where data was collected from both the literature and company interviews. The findings from these data searches were analyzed and resulted in a Green IT Balanced Scorecard.

Creating the Green IT Balanced Scorecard in advance and testing it with reality, which would have been consistent with a deductive approach (Saunders et al., 2009), might also have given good results. However, with this approach some vital questions and findings might have been missed because the authors were too focused on the already proposed solution. The inductive approach forces the study to look for all possible solutions and ways of thinking around Green IT, and therefore receive a fuller picture on the matter.

3.3 Research Design

3.3.1 Research Purpose

Robson (2002) defines exploratory studies as "[finding out] what is happening; to seek new insights; to ask questions and to assess phenomena in a new light" (cited in Saunders et al., 2009, p. 139). As mentioned previously, research on Green IT in Sweden, and Green IT Balanced Scorecards internationally, has already been conducted. However, no research has been done on a Green IT Balanced Scorecard model based on the Swedish environment.

Thus, in this subject the authors see that research on the matter is needed. This thesis sets out to see what Green IT practices are currently used in the Swedish environment with the help of the different perspectives of the Balanced Scorecard. The authors mean to asses Green IT practices in Sweden, through a new light and create a new Green IT Balanced Scorecard model separate from those previously done. In other words, not based on the previous research of Green Balanced Scorecards. Therefore, this study is exploratory in the sense that new insights are being explored by looking at practices in the Swedish environment and presenting these in the Balanced Scorecard model. The reason for doing this is to

create a model exclusively for the Swedish environment that was not influenced by outer sources or other regions.

3.3.2 Research strategy

The authors have chosen to use case studies in this research. Case studies are defined as "a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence" (Robson, 2002, cited in Saunders et al., 2009, p. 146). Morris and Wood (1991) defines it further by saying that case studies can give a deeper understanding of the research context and its processes (cited in Saunders et al., 2009). This is consistent with the purpose of investigating what Green IT practices are used within the Swedish environment, and then applying these to the perspectives of the Balanced Scorecard model.

Yin (2003) establishes two dimensions in case study strategies that the researcher need to choose between (cited in Saunders et al., 2009):

single case v. multiple case;

holistic case v. embedded case.

For this thesis, a holistic multiple case study technique was used. Using multiple cases from separate industries allowed the authors to base their research on the Swedish environment that is in accordance to the research question. This strategy ensures that the practices found reach similar results and that they are not unique to a particular industry, but actually used throughout the Swedish environmental. Thus reaching literal replication, as defined by Yin (2003). This study also takes a holistic view of the organization, seeing it as a whole, and does not concern any specific departments, since Green IT is used throughout the organization, even though it is mostly managed by the IT department.

When using a case study strategy, the data can be triangulated, in other words using several data collection techniques within a study in order to ensure that the data is reliable (Saunders et al., 2009). This was achieved in this study by comparing the resulting practices from the empirical findings with the Green IT practices found in the literature. Hence ensuring that the IT practices considered to be "green" by the Swedish companies are also considered to be Green IT practices in the scientific environment.

3.3.3 Method Choice

Saunders et al. (2009) explains that quantitative and qualitative data can be used for data collection and analysis. The authors have chosen to use qualitative data collection and analysis techniques in order to find and understand techniques and concepts of Green IT practices and to be able to find the IT practices that are considered to be "green" by Swedish organizations. Since Green IT is a dubious concept, a qualitative method choice will allow the authors to get more accurate findings that will provide context to the thesis.

This thesis is built upon multi-method qualitative study as it uses two data collection techniques and one analysis procedures (Saunders et al., 2009). Two different data collection techniques have been used in order to ensure triangulation of data.

3.3.4 Time Horizon

This study has a cross-sectional time horizon that Saunders et al. (2009) defines as a 'snapshot' of a particular phenomenon at a certain time. As the research question concerns what

practices are used in Swedish companies at the moment of the interview, the study will result in a "snapshot" of Green IT practices in the current Swedish environment which may cause difficulties for the replication of this study.

3.4 Data Collection Techniques

Secondary data from litetarture, which Saunders et al. (2009) defines as data collected previously for another purpose, and interview data collected for emprirical findings are the two sets of data used for this study.

3.4.1 Secondary Data

A preliminary literature search was started in order to get to know the subject area and to create, and later refine, the research question. The parameters for the literature search were to find publications in both English and Swedish, within the subject area of Green IT. No specific geographical area or publication period was selected.

Saunders et al. (2009) lists three different types of literature sources; primary, secondary and tertiary sources and in the preliminary search all three of these sources were included The search started with exploring the Internet, using the search engine Google Scholar, the Jönköping University Library website and the Swedish website for academic research, DIVA, that are tertiary sources. Initially, the only keywords used were 'Green IT', and the Swedish translation 'Grön IT'. After the preliminary search was started, it was found that the scientific journal *IT Professional* and the author Murugesan had published a considerable amount of material on the subject matter and had been referred to in many of the sources that were found. Thus, these two also became keywords used in the search, as they are key actors within the subject field.

Literature from several different sources, both primary and secondary, focusing on different aspects of Green IT was found. The findings both included discussions of the overall topic of Green IT, the evolution of it and techniques that were considered to be Green IT practices. In addition, this created the basis for the Frame of Reference section that was later expanded further as new techniques were found through the empirical findings, mentioned below.

The purpose was to find Green IT practices and not further explain how each technique is technically implemented or evaluated. Therefore, focus was only put on the literature that explained why they were considered to be Green IT practices. Also, many of the resources considered several techniques in one publication, such as Unhelkar (2011a) and Tomlinson (2010), and therefore they were considered as key literature for the Frame of Reference.

As a further matter, to find more information about the Balanced Scorecard model, the Jönköping University library was used for book search on the topic. The authors had both worked with the model in previous courses and therefore material from these was used.

3.4.2 Empirical Data

Saunders et al. (2009) defines semi-structured interviews as interviews that are based on a list of themes or questions that the researcher follows. However, depending on the flow of the conversation, the order of these themes or questions can be altered. Some themes or questions may also be added if they are significant to the organizational context, or excluded if they are not (Saunders et al., 2009).

The reason for choosing this interview type was to get deeper understanding of the Green IT practices used in Sweden. In the initial stages of the literature search, the authors found that several authors defined Green IT differently and it was therefore assumed that the companies would also have different views on the topic. Semi-structured interviews enabled the authors to explore the interviewee's thoughts and perceptions of Green IT that resulted in practices that had not been considered before. This could not have been achieved through sending out a questionnaire to the companies.

Based on the literature that was found on Green IT and the Balanced Scorecard model, an interview guide was created and that can be found in Appendix 1. These questions all considered the different perspectives of the Balanced Scorecard model and tried to find out what Green IT practices the companies used. However, these questions were only used as guidelines for the interviews and sent to the interviewees beforehand so they could prepare, making sure that all topics were covered. Three of the interviews were conducted face-to-face and became more of a discussion, where the companies explained what practices they were using, the thoughts behind them and how they worked. One of the interviews was conducted over the telephone and over email, due to time limit on the interviewee's side. This interview was shorter and only explained what practices that were used and did not go into the same level of detail as the other interviews did.

The three face-to-face interviews were all audio-recorded, with the interviewees' permission, and transcribed within days of the interview in order to assure that data was not lost. The transcriptions and notes were for internal use only and were not sent to the companies. However, in order to ensure that the data had not been misunderstood, the individual empirical findings were sent out to each company interviewee, before the thesis was published, so they could approve the Result section.

In the thesis, the company and the interviewees' names have been removed to eliminate the possibility of biases towards the companies chosen or the people interviewed. The company names have been changed to Company A, B, C and D, depending upon the order of the interviews. In other words, the interview with Company A was held first, Company B second and so on.

There are two types of sampling techniques, probability and non-probability. Non-probability sampling was used for this study, where the probability was not known, and was done through the researcher's subjective judgment (Saunders et al., 2009). This technique was chosen because the research question did not require any statistical valuation of the population.

The sampling technique used was purposive sampling, with a heterogeneous sampling strategy. A purposive sampling technique can be applied when a small sample is used, such as in case studies, and lets the researcher use his or her judgment to find the cases that will best suit the purpose of the research. This technique also allows the researcher to find cases that are especially valuable and informative than others (Neuman, 2005, cited in Saunders et al., 2009). Moreover, a heterogeneous sampling strategy permits the researcher to observe and describe the key themes in the subject. Patton (2002) argues that even though the sample size might be small, it can still contain cases that are different from each other, which can enable the researcher to find key themes that are particularly valuable and also define uniqueness (cited in Saunders et al., 2009).

To be able to find cases that were more informative than others, the Internet was used to search for companies that had a stated climate policy on their website. The companies were

then chosen within separate industries to get a wide spectrum of knowledge and uses of IT, and employees that have knowledge about Green IT usage in the company were interviewed.This enabled the research to investigate what Green IT practices were used within the Swedish environment and what Green IT practices were unique to a specific company. However, since only one company was investigated within each industry, it cannot be proven that the Green IT practice was unique to the company or the industry.

3.5 Credibility of Research

The reliability of the data is threatened by the biased nature of the interviewees' opinion (Saunders et al., 2009). Since the interviews were conducted with only one or two interviewees and were therefore alone responsible for answering questions regarding why they implemented Green IT, and if they were successful. The drivers that were found are only based on their opinion that might not correlate to the entire organization's opinion. However, since the research mainly considers the Green IT practices of the company, they are not affected by the interviewee's opinion.

Another threat to the reliability of the data comes from the interview structure chosen, semi-structure. This type of structure can lead to observer error as questions could have been asked in different ways to the separate companies (Saunders et al., 2009). However, the authors see that several practices, not thought of prior to the interviews, were found through this type of interview structure that might otherwise have gone missing. In addition, by providing the interviewee with the interview questions in advance, they had the possibility of preparing themselves with answers and material prior to the interview time. However, due to the fact that many people can interpret Green IT differently, it was still difficult for the interviewees to fully understand what the different interview questions asked of them.

The interviewer misinterpreting what the interviewee meant when answering a question can causes interviewer bias (Saunders et al., 2009). However, this threat to reliability was reduced by, as mentioned, sending out summarized extracts of the interviews back to the companies to get them approved, ensuring the right information was understood by the interviewer.

The reliability of the secondary data has been done by evaluating the reference sources of the authors chosen, looking at the type of publication and the amount who have referred to the publication itself. The authors have opted to choosing scientific articles in well-known scientific journals, published books on the topic as well as looking at official government websites. The authors realize that Internet searching is unreliable and can be biased, however, Internet searches where needed due to time and resource constraints. Therefore, those websites that were used as sources were evaluated and checked for reliability. If a source was not considered reliable, it was not used as a reference in this essay.

3.6 Data Analysis

The data analysis in this thesis follows the inductive approach of the study. It also uses an analysis procedure, based on Miles and Huberman's (1994) work, called Data display and analysis. This procedure constitutes three main activities: data reduction, data display and drawing and verifying conclusions (cited in Saunders et al., 2009).

The first step, data reduction, involves activities to summarize and condense collected data (Miles & Huberman, 1994, cited in Saunders et al., 2009). Saunders et al. (2009) lists three types of processes to group data; summarizing, categorization, and structuring of meanings.

After transcribing each interview, they were summarized into key points, to get an overview of the main issues discussed during the interviews. These summaries are shown in the Results section of the thesis.

From the key points of the interviews, several similarities were found between the IT practices that the different companies used. In accordance to the second step of the analysis procedure, data display, the findings were organized and assembled into a diagrammatic display, using a matrix (Saunders et al., 2009). Since this thesis is orientated towards the Swedish market, the IT practices found during the interviews are the only IT practices displayed in the matrix. In addition, during this phase, the authors realized that in order to ensure that the IT practices found in the empirical data were established Green IT practices even in the scientific environment, they also needed to be confirmed by authors within the field. Therefore, in the matrix, displayed on the x-axis is the various IT practices found in the empirical data and on the y-axis are the authors, mentioned in the frame of reference, as well as the interviewed companies. A black dot represent the company or author that use or support the IT practice mentioned. Also included in this matrix was a circle representing the company who had yet to, or wished to, implement the IT practice in the future.

To ensure validity of data and that the IT practices mentioned in the matrix are actually real and valid Green IT practices, the authors have decided to only include certain practices in the third and final step of the analysis procedure. These include those practices that are mentioned by three sources, one author and used by at least one company. Thus, those practices that have yet to implemented into a company are not included in this.

In addition to the IT practices that were found in the empirical data, the authors also found several reasons why the companies decided to implement Green IT into their organization. During the interviews the companies stated the reasons in different ways, but the authors saw that some of them were based on the same needs. The similar reasons were matched together into, what the authors realized could be distinct drivers behind the implementation of Green IT. However, just as the IT practices, the drivers also needed to be confirmed drivers in the scientific environment and a matrix similar to the one above was created.

For the third and final step of the analysis procedure, drawing conclusions and verification, the original four perspectives of the Balanced Scorecard needed to be examined to determine whether or not they needed to be adapted for the Green IT Balanced Scorecard. Using the inductive approach, the authors looked at the empirical findings and saw that matching each of the drivers mentioned above to the original perspectives could do this verification. It was found that at least one driver supported each perspective and therefore verified that all of the perspectives could be used in the Green IT Balanced Scorecard. In addition, since all of the drivers could be matched to the original perspectives, the authors saw that no additional perspectives were needed.

In the Balanced Scorecard model, presented in the frame of reference section, each perspective had its own question stating what the perspectives' aim is. The authors see that these could be rewritten to fit the Green IT strategy and this was done with the help of the drivers and what their contribution was to each perspective.

The traditional way of constructing a Balanced Scorecard model, according to Kaplan and Norton (1996b), is to translate the business strategy into objectives for each perspective. However, due to limited information about the business strategy from the empirical data, and because the empirical data comes from several different companies, the building of the

Balanced Scorecard model had to be reversed. From the empirical data, several Green IT practices had been found and these practices could be seen as techniques for Green IT and could be turned into action statements that could be comparable to initiatives in the Balanced Scorecard.

After all of the IT practices had been turned into initiatives, the authors saw that most of them contributed to internal process improvements, or the reengineering of business processes, to become more environmentally friendly through the help of IT. Thus the authors started by matching similar initiatives together to form objectives in the Internal Processes perspective that contributed to process improvement. From this stage the authors found that these process improvement objectives also contributed to financial savings in the financial perspective and objectives were therefore formed in this perspective. The same kind of analysis thinking was applied to completing objectives for the customer and employee learning and growth perspectives.

The objectives and initiatives found were then placed in the Green IT Balanced Scorecard model for the final presentation of the findings of this study.

4 Results

Below are summaries of the key issues, objectives and practices discussed in the interviews with the four companies.

4.1 Company A

Company A, based in Jönköping, is an IT-service provider for all sizes of public and private organizations. Their IT-services focus on Virtualization, Functional IT and Operation services. Company A has a clearly stated climate strategy and is triple-certified with environment (ISO 14001), working environment (OHSAS 18001), and quality (ISO 9001) certifications. In addition, Company A was recently awarded for having the most environmentally friendly data center in Sweden.

The interview was conducted with the CEO and Head of Consultancy at Company A in Jönköping.

Being ISO 14001 certified forces Company A to work with all aspects between evaluating the environmental impact of their suppliers to recycling their own products. The certification works like a matrix, ensuring low-impact work in a broad spectrum, covering all aspects of the organization. For example, when procuring products internally, they look at if the material used in the device comes from recycled material, and at present, all their computers are Svanen-labeled. In addition, when procuring large quantities of products they order the products unpackaged, if possible, even though ordering this way is more expensive. Ordering unpackaged both saves material usage, as well as they save the money it would otherwise cost them to recycle the packaging. In addition, Company A sort all their waste and recycle it according to local legislations.

Since Company A cannot control all aspects of the procurement process; they try to evaluate each supplier individually by sending out supplier evaluation forms. The company then rates their supplier from one to five, based on the answers, and if a supplier has less than three, Company A has to evaluate if they should employ them as suppliers or not.

Due to the triple-certification, Company A has a responsibility to educate its staff in environmental conservation, recycling, energy-reduction and emissions, and in what choices they can make to promote Green IT.

The environmentally sound technologies used for the data center at Company A are: free cooling, DC fans in cooling aggregates, Novec 1230 - an environmentally friendly extinguishing fluid, virtualization - to reduce physical hardware, UPS with high efficiency, energy-efficient processors and memory devices, blade servers and switches, using only renewable energy, separate energy meters for the datacenter, hot-aisle-cold-aisle server placement.

Company A is also working on process improvement by adapting PUE-numbers to measure effectiveness of data center, reduce work-related traveling through new technologies (phone and web conferences), implement e-invoicing, as well as turning off lights, computers, and copying machines after working hours. In addition, they have placed all of their printers in a central position in order to reduce both the total number of machines and limit the number of pages printed daily. Company A is currently trying to use as many e-invoices as possible to reduce their paper-consumption. These initiatives are managed through a management system, that stores supplier evaluations, PUE-numbers, and also see how many e-invoices they have sent.

Company A see a benefit in that they are ISO 14001 certified, as it provides a guarantee that the organization is always working towards becoming more environmentally friendly. When evaluating a supplier, a company can give more points to a supplier that is working in with ISO certifications.

By working with ISO 14001 and making active choices to be environmentally friendly, Company A see sustainable practices and saving money as reason for becoming green. In addition, they also see the potential in marketing themselves as an environmentally friendly company with sustainable solutions, which in turn will lead to more sales. Also, by getting prizes, like having the most environmentally friendly data center in Sweden, they get a lot of free advertising and a market value that could not be bought for money in the market. However, they do not know if the customers chose their services because they are environmentally friendly, but hope that it is a contributing factor to why they are chosen.

4.2 Company B

Company B is a Jönköping-based company working with production and distribution of electricity, district heating, district cooling, biogas and bio fertilizer. They also work with electricity trade and data broadband network. Company B has a clearly stated climate policy, and is ISO 14001 certified, meaning that they are working towards resource reduction in all areas of production. The interview was conducted with the Head of Administrative IT, Interviewee 1, and an environmental engineer, Interviewee 2.

Company B is a subsidiary of Company C, presented below. Therefore, when Company C built a new data center, Company B moved all their rack-servers to this facility. In the beginning, Company B operated from five racks of servers but has now, through virtualization, been able to reduce it to only three racks. Since they do not own the data center themselves, they did not benefit from any savings in the reduction of physical hardware in the form of energy reduction. However they did reduce their rent from Company C, who charges based on data center floor space needed. They have also started using blade servers and DC fans, utilizing seven base frames in three racks, to get even more productivity for the space they are renting. Company B has full access view of their real time usage of energy in the data center.

Even though virtualization and switching to blade servers has increased investments costs for Company B, they argue it was a necessary cost. If they had stayed with the old technology, more staff would have been required. They also saw benefits in using less space and energy reduction. In total, Company B has about seventy virtual servers on seven physical servers and they say that even though they had some minor problems with virtualization in the beginning of the implementation, they are now very satisfied with the results and only see benefits in, for example, resource minimization.

Company B does not market themselves as IT-environmentally friendly, because it is more in the nature of the energy industry to promote that they have and provide renewable energy sources and reduce greenhouse gas emissions. Company B discussed during the interview the recent trend within virtualizations, thin clients. However, Company B does not think that the technology is mature enough and do not see how this approach could benefit the company at the moment. They do, however, see it as a future opportunity to become even more efficient.

Another issue discussed at the interview was web-conferences. Since Company B, due to its type of industry, the company does not visit many of its customers and therefore they ar-

gue that they would not save any money or resources by installing a web-conference system. They do, however, use phone-conferences and share screens online when needed.

When Company B recently installed a new e-mail system, the first priority was to reduce the amount of emails stored to both save time spent on the projects as well as memory space. To get the employees interested and involved, they started an "Email clean-up, save a server"-campaign, where they awarded a small, but significant prize to the employee who deleted the most emails. The campaign was successful and they managed to reduced the email storage space by 49% in four weeks.

Company B is also working with a Document Management System to get a better control of the documents on the servers and minimize duplications. Instead of sending whole documents in emails, which require more space; they instead put the document in the Document Handling System and send the link to it.

Another aspect that Company B is working with is to minimize paper usage. They have set the standards on the copying machines to black-and-white and double-sided printouts.

Company B is ISO 14001 certified and see only benefits with this. They view it as a management system that lets them see the process-based structure of the company that enables them to manage it in a better way. Company B is always trying to buy as environmentally friendly computers as possible, but mention that they have a hard time recycling. The company had a contract with a firm that recycled their old computers, however they unfortunately went bankrupt, and, according to Interviewee 1, there is now no environmentally friendly way of recycling computers in Jönköping at the moment.

Since all computers are updated during the night, the IT-department of Company B, want the computers to stay on during the night. This wastes a lot of energy, but they argue that it otherwise would take too long to start the computers in the morning. Again, they think that the technology is not mature enough for them to implement some kind of central control mechanism that could turn off the computers centrally when the updates are done.

Company B does not educate their staff in Green IT or the like, but are considering educating them in Microsoft Word and Excel, because they see that these programs are commonly used. Interviewee 2 finds that talking to the employees, one by one, and, for example, telling them to only send links instead of documents is useful. The interviewee argues this method is better because then the learning process can be adapted to the individuals needs.

4.3 Company C

Company C is a government owned company based in Jönköping, with a total employee base of 11 000. Company C has a clearly stated climate policy, where they actively work towards being environmentally friendly in all aspects. The interview was conducted with an operation manager of the IT-department of Company C.

Company C have environmental requirements on all computers and are currently using Fujitsu computers and screens that are well known for their climate smart computers, and TCO labeled. All the stationary computers at Company C are environmentally friendly, however, not all laptops are.

Company C is always trying to maximize their computers' life cycle, however, due to wear and tear, replacement and recycling is necessary after four years. They are currently working

on introducing a new platform in the organization, making it possible to use the computers even longer. This will be achieved by replacing old computers with new, smaller ones, used as thin clients that are more energy-efficient.

The data center at Company C hosts eighteen racks of servers, where many of them contain blade servers. Due to a restructuring of the organization in 2006, they built a new data center and introduced blade servers as they are easier to maintain and are more energy-efficient. Company C is also trying to virtualize as many servers as possible and has so far virtualized 40-50% of their data. When the new platform is introduced, they will achieve a percentage of 50-60%.

The cooling in the data center is done through cold water and three cooling machines, and a reconsideration of the placement of these cooling machines will soon be done. Together with the supplier, they will evaluate if the placement of the three cooling machines can be made more efficient, providing better cooling, and thereby resulting in better energy-efficiency and less environmental impact.

All email inboxes has a limited storage space, this because it will be faster to restore if something happens, and to limit the storage space on the backups. The interviewee mentions that the amount of data in the organization is a problem. For example, the system contains a lot of duplicated data that no one has full control over. Company C is currently not using a document management system, but the interviewee is sure that it will be considered soon. He also states that, with the new platform, this type of system might be introduced.

Company C does not use any specific measurements of their environmental impact, but the interviewee recognizes that it could be beneficial, even though he states that it could be hard to implement. The IT department can see the energy-usage of the data center, however, since Company C provides IT to many branches of its organization, they cannot see themselves as owners of the computers, and can therefore not measure total energy usage. However, they do encourage users to turn off their computers when they go home for the day, and provide more information about how to be environmentally friendly on their intranet.

Company C does not educate the employees in Green IT, however, the interviewee believes that this should be initiated in the company. Education should be part of the introduction for new employees and could then result in long-term benefits and achieving behavioral change in the culture at Company C.

In order to reduce the amount of printed pages in the IT department, they have reduced the number of printers from four to two, and placed them in a central location. The interviewee thinks that this makes the employees reconsider if they really need to print every document, and this thinking hopefully results in minimized printings. In the latest purchase of printers, Company C had environmental requirements, such as recycling of toners amongst others. As Company C has to deliver what the branches of the organization order, they cannot reduce the number of printers and copying machines they need and want, but they do, however, talk to the branches to make them more aware of the available solutions. They also pre-program all the scanners and copying machines to double-sided printings and sleep modes. The interviewee feels that they have reached a good level internally.

A traveling policy was recently sent out to the employees, encouraging them to choose the means of conveyance that is the most environmentally friendly. The policy also states that telephone and web conferences should be used as much as possible. Every conference

room has a conference telephone, and shared screens are also utilized at meetings. Additionally, in order to not travel as much, as many errands as possible are solved through distance control.

Several departments of Company C are currently ISO-certified, however, the IS/IT department is not. As Company C own Company B, who only produces renewable energy, it can be inferred that Company C only uses renewable energy.

4.4 Company D

Company D is a large player in the Scandinavian hotel industry, with a total of 160 hotels in nine separate countries. The company works actively in creating a sustainable company, and has a well-formulated environmental strategy. The interview with the company was conducted over the phone with Interviewee 1, who is a Business Controller at the Jönköping based office. Interviewee 1 then contacted Interviewee 2, who works at the centralized IT department for further information.

Company D have just went through a major IT transformation in the past year, installing a new platform as well as moving all the servers located at the separate hotels to one common location in the south of Sweden. This new common location for the data center has allowed Company D to choose strategic placement, in order to take advantage of the environment around the data center to run it. In addition, all servers are now located in within the same area, allowing them to reduce the total number of hardware needed to for example cooling hardware and network connections. Also, better end user support can be given through this move, support through distance control is right now being used and thin clients is in the rollout phase at Company D.

The move has also resulted in new printing policies. The number of printers have been reduced, and placed centrally so that it can easily be managed. Also, Company D try to always print double-sided and in black-and-white where appropriate. In addition, the move also resulted in a new email system with a limit on the amount of emails per user. However, this limit can be increased if the role of the user requires that. Another, new application that became active with the change, is the use of e-invoices. E-invoices reduce the number of pages printed and are sent out to those customer and suppliers who can accept and handle them.

All hotels at Company D are Svanen-labeled; they use both Energy STAR and TCO labeled end-user devices, and procure only eco-labeled computers. Company D has a policy of turning off all unused end-user devices at the end of the working day, as part of the Svanen-standard. They also value phone conferences before traveling to different locations. Through showing the Svanen label externally, the company also market themselves actively as a "green" company to the general public. Company D also conduct some measurements assessing how sustainable their IT is. These measurements show results in lower energy consumption, a better image to the general public as well as CO2 reductions.

When hard drives are replaced, the old ones are either sent back to the supplier to be used as spares, or recycled at a recycling station. Interviewee 2 also mentions that the organization has an active policy dealing with recycling of other old IT assets.

Company D does not offer any Green IT education to their employees at the different hotels.

5 Analysis

The following section presents an analysis based on the data found in the frame of reference and the empirical findings. Firstly, the IT practices that can be established as Green IT practices are presented, along with the drivers that urge on the implementation of Green IT. Thereafter, initiatives are established and turned into objectives that will form the Green IT Balanced Scorecard.

5.1 Green IT Practices and Drivers

The summaries of the interviews above have introduced several different IT practices that the companies use and consider to be green. In order to ensure that these are established Green IT practices in the scientific environment, they were linked to the authors who had mentioned them in the frame of reference section. The matrix found in appendix 2 examines the different IT practices used together with the authors and companies that mention them. The practices that are supported by at least three sources, used by at least one company and mentioned by at least one author is regarded as a Green IT practice and is presented in the table below (see Table 5.1).

Included in this table is also the Green IT practice Cooling techniques. This practice is a combination of the different types of cooling technologies, found during the interviews. Since the companies interviewed all used different cooling techniques, the authors saw that no standard technique for the Swedish environment could be found. Nevertheless, it was seen that cooling techniques are an important practice within Green IT and the authors therefore chose to define Cooling techniques as an overall practice in itself.

Green IT Practices		
Blade servers	Evaluating suppliers	Svanen
Buying eco-labeled devices	Green IT education	Strategic data center placement
Communication equipment	ISO 14001	Switching off devices not in use
Cooling techniques	Recycling	TCO
Effective printer standards	Renewable energy sources	Thin clients
Energy STAR	Smart energy meters	Virtualization

Table 5.1 Green IT Practices used in the Swedish environment

The authors saw that, in the interviews, it was easier to find and discuss concrete IT practices used in the implementation of Green IT, rather then to find the drivers or reasons behind the implementation that were more diffuse. It was recognized that within the different industries, IT practices were alike. However, the drivers that were discussed were expressed differently by the companies, but were based on similar needs. For this reason, the needs of the different companies were combined into similar drivers for Green IT that will be discussed below.

The first driver that was found in the interviews was **Competitive Advantage**. Both Company A and D stated that they market themselves as green companies and Company A saw this as a way to gain more sales. New market opportunities, has been defined as a driver of Green IT by Nidumolu et al. (2009) and Unhelkar (2011b). Unhelkar (2011b) explained that Green IT can be seen as a new market opportunity that provides companies with several possibilities to compete and outrival competitors. In addition, Company A saw their ISO-certification as a way to look legitimate towards the customers, which is in ac-

cordance to Lamb's (2009) and Murugesan's (2008) statement that Green IT solutions can be implemented for competitive reasons to look better towards the end customer as compared to other competitors.

A second driver that was found during the interviews was **Cost Savings**. Both Company A and Company B mentioned during their interviews that saving money could be done by adapting and refining new processes in their businesses using environmental thinking. This new thinking could reduce either the amount of physical machines, or reduce the amount of energy consumption in business process. Both Murugesan (2008) and Unhelkar (2011a) agree with this statement of optimizing processes to reduce costly steps, as well as costly physical machines, resulting in reduced overall costs as stated by Nidumolu et al. (2009). Both of the companies, A and B, mentioned the high initial cost of investing in greener infrastructure, but argued that after the payoff period, the resources needed to operate the infrastructure was lessened and therefore money was saved.

Several authors proposed that Green IT practices, such as virtualization and reengineering end-user device practices, can be a way of both reducing energy consumption and hardware usage (Kristiansson, 2008; Lamb, 2009; Murugesan, 2008; Unhelkar, 2011a). All companies interviewed stated that they had implemented different Green IT techniques in order to reduce energy consumption and resource usage. For example, Company B used virtualization to reduce the hardware usage in their data center to be able to maintain it, and Company D have started implementing thin-clients in their organization to reduce the number of physical machines. As a reduction in energy and hardware consumption results in less resources being used, the driver **Resource minimization** was established.

The fourth driver contains a broad spectrum of reasons that both companies and authors mentioned, having its basis in being able to **Survive** in the market. Company B opted to implement Green IT practices in order to keep up with the demand for IT solutions, without having to increase the number of employees drastically. Also, Company C had to implement new ways of working with IT due to a restructuring of the organization as a whole. Unhelkar (2011a) and Murugesan (2008) both argue that survival can be a driver if government legislations call for a change and improvement of carbon emissions from an organization. Unhelkar (2011a) continues to state that even social pressures from customers demanding greener practices and pressures from suppliers can cause an organization to rethink its IT in order to keep up and survive in the market.

The last driver that was found in the interviews was **Sustainability**, as promoted by Nidumolu et al. (2009) and the Swedish legislation (Sveriges Riksdag, 2012). Company A stated this as a reason to become green, and Company D is actively working with their IT to become more sustainable and use measurements to assess their level of sustainability. Therefore, this can be seen as a Green IT driver in the Swedish market.

Table 5.2 below shows a summarized table of the drivers behind Green IT that have been mentioned. In appendix 3, a matrix shows which authors and companies support and use these drivers respectively.

Drivers of Green IT
Competitive advantage
Cost savings
Resource minimization
Survive
Sustainability

Table 5.2 Drivers of Green IT used in the Swedish environment

5.2 Green IT Balanced Scorecard Perspectives

The purpose of this thesis is to create a Green IT Balanced Scorecard adapted for the Swedish environment. The envisioned end result will be a Balanced Scorecard that looks at objectives to improve IT functionalities supporting business, with an overall goal to improve the environmental impact of the firm and promote sustainability. The original Balanced Scorecard includes four perspectives and in order to ensure that these four perspectives are sufficient for the Green IT Balanced Scorecard, the authors compared each perspective to the different drivers mentioned above.

The Financial perspective ensures that the organization is getting a positive effect financially through its business strategy investments. In a Green IT Balanced Scorecard it was found that the driver *Cost Savings* can be linked to this perspectives as it deals with reducing resource cost through the investment of Green IT that ensures financial profitability of the investment in the long run. As mentioned, investment cost for Green IT are relatively high in the beginning, however, money can be saved after process improvement through Green IT. The link between the two concepts has lead to the modification of the question for this perspective. The new question for the Green IT Balanced Scorecard's Financial perspective is as follows: To succeed financially, how can we ensure financial pay-off through Green IT investments?

The Internal Processes perspective deals with improving and reengineering business processes according to the business strategy. The authors saw a link from this perspective to the driver, *Resource Minimization.* This driver deals with business process reengineering, with a focus on reducing IT resource usage in all business processes with the help of investment in Green IT. Also here the perspective question was adapted to fit the link between the two concepts: To reduce our environmental impact, what processes must we excel at?

The Customer perspective defines who the customers are and what they demand from the organization. Relating this perspective to the Green IT Balanced Scorecard, the authors would argue that both customers of the company as well as the organization itself are part of this perspective. External customers are very critical and compare the business with its competitors within the same markets. So through the use of the driver *Competitive Advantage*, Green IT investments can aid an organization to look better to the external customers and thus winning their business. Also, as the business grows and new ways of working emerge, the IT demand increases which leads to an increased use of resources. Therefore, IT also needs to change in order to deal with the increasing demand, and through the implementation of Green IT the organization can answer to this pressure and still ensure that resource usage is minimized, which is similar to the driver *Survive.* The authors saw that the original Customer Perspective's question fits well even with Green IT as a strategy: To achieve our vision, how should we appear to our customers?

The Employee Learning and Growth perspective ensures that the organization can respond to changes in business requirements in the future. The authors saw a direct connection with this perspective to the driver *Sustainability* that deals with ensuring that resource usage today does not affect resource usage tomorrow. In other words, making sure that the resources used presently in the organization does not limit the organization's ability to do business in the same way in the future. Through Green IT, the resource usage can be controlled and also help deal with political pressures from Sweden to becoming a sustainable company. In addition, managing the users skills regarding sustainable IT practices is also part of this perspectives and ensures sustainability throughout the organization. The question for this perspective in the Green IT Balanced Scorecard is: To achieve our vision of sustainability, how can we change and improve?

Overall, it can therefore be argued that all of the four perspectives in the Balanced Scorecard can be used in the creation of a Green IT Balanced Scorecard. In addition, the authors also saw that an additional perspective was not needed because all of the drivers that were found could be linked to the original perspectives and the authors would argue that no driver, or reason behind the implementation, of Green IT in the Swedish environment was unanswered in these four perspectives. Therefore, the four original perspectives are used in the Green IT Balanced Scorecard, however, as seen the perspectives" questions are adapted to fit a Green IT strategy.

5.3 Initiatives and Objectives

In the frame of reference it was explained that in order to create a Balanced Scorecard, a company must first decide on a strategy behind the implementation and then break this strategy down into actionable and understandable objectives that can easily be measured. However, since the empirical findings did not result in any concrete strategies, objectives or measures, difficulties arose when it came time to create the Green IT Balanced Scorecard.

In spite of that, from the empirical data several Green IT practices specific to the Swedish environment were found. The IT practices can be seen as very concrete techniques of working with IT to improve the environmental impact of the company. By reformulating these into action statements, for example *Virtualization* into *Implement Virtualization*, they can then be compared to initiatives in the Balanced Scorecard model. Initiatives according to Kaplan and Norton (1996b) are actions that a firm takes to reach an objective. Thus, by using these initiatives, it can in a reverse way create the Balanced Scorecard by first looking at what benefit the initiatives have and from there form objectives that can be linked to a specific perspective.

When looking at the initiatives it was found that most of them contributed to process reengineering, or improving the way internal processes affected the environment. Therefore, to build the Balanced Scorecard model, objectives for the Internal Processes perspective were first discussed in order to initiate the process.

Data centers in companies are big environmental thieves, due to the increasing size and demand of them. Thus, data center improvement alone is an important objective for the Green IT Balanced Scorecard, resulting in the Internal Processes perspective objective; **Reduce data center environmental impact.** This is a comprehensive objective that covers the way the company builds, operates and controls its data center. Several initiatives, such as *Installing blade servers, smart energy meters, Implementing virtualization, Improving cooling techniques* and *Strategic placement of data center* all contribute with similar benefits to the data center, as discussed in the frame of reference and in the empirical findings. These initiatives

contribute to benefits such as minimized hardware usage and reducing and measuring energy consumption in the data center, resulting in a reduced environmental impact of the data center.

In addition to this, reduction in energy consumption and resource consumption can also take place in the organization, outside of the data center, through the help of several initiatives. Initiatives such as *Reducing the number of physical machines, Switching off user devices not in use* and *Using thin clients and Energy STAR-, Svanen- and/or TCO-labeled products* all benefit to reducing the energy consumption for IT products in an organization, resulting in a second objective, **Reduce energy consumption.** Implementing effective printer standards results in *Reducing the number of prints* as well as *reducing number of physical machines*, actively contributing to the reduction of resources, along with *Implement communication equipment* to reduce traveling resources that all result in the objective **Reduce resource consumption.**

The final objective in the Internal Processes perspective considers another trend that was also found. The IT asset life cycle has an effect on the environment and should therefore be controlled from the beginning to the end in order to improve its environmental impact. The objective **Improve IT asset life-cycle** is based on benefits gained through procurement initiatives such as *Buying eco-labeled devices* that *Use Energy STAR-, Svanen- and/or TCO-labeling* and by *Evaluating suppliers,* as well as improving the end-of-life-cycle initiative *Recycling IT products*.

The next perspective in the Green IT Balanced Scorecard that was looked at was the Financial perspective, because several objectives in the Internal Process perspective showed that they would result in financial benefits. The first objective in this perspective, **Reduce energy cost**, is based on the same initiatives as found in the Reduce energy consumption objective, but also includes initiatives for energy consumption reduction in the data center. These initiatives for the data center being the *Implementation of virtualization, improving cooling techniques, strategic placement of data center* and *installing blade servers.*

The second objective in this perspective, **Reduce operational cost**, is also based on the same initiatives as the Internal Processes objective, Reduce resource consumption. Their similarities are based on the fact that by reducing the day-to-day operation resources, operating cost of the organization will decrease. In addition, initiatives that also reduce operation cost in data centers are included in this objective such as *Implement virtualization and install blade servers.*

The two perspectives above are based on benefits that come directly from implementing the initiatives. However, for the Customer perspective, the objectives require both implementing the suggested initiatives, as well as communicating the use of the initiatives to the external environment. Therefore, the objective **Improve company's environmental image** specifies the need of the organization to promote the most vital and relevant Green IT practices that they have implemented.

In addition to this, the Customer perspective, as mentioned, deals with both external customers to the organizations as well as the internal IT users, who both can put pressure on the organization to change. The external customers may want the organization to become more environmentally friendly and the authors saw that implementing Green IT can aid in this since IT is a big part of the organization. Pressure can also come from the internal IT users demanding new supporting functions after, for example, a restructuring of business functions that then demand more IT support than possible in today's infrastructure. Therefore, it would be argued that Green IT is a solution that meets the growing demand, with-

out having to increase the amount of resources. Thus, the objective **Manage social pressures** deals with looking at these pressures and acting accordingly. In the Green IT Balanced Scorecard model, presented below, several initiatives have been suggested that the authors see an average customer would like to see in an environmentally friendly company, as well as important Green IT techniques a company should promote to their customers. However, from the data, it was not possible to determine what the average customer would like to see and therefore these were interpreted from the authors learning of the subject. Therefore, they are not based on scientific evidence and reasoning.

The last perspective that was developed for the Green IT Balanced Scorecard model was the Employee Learning and Growth perspective. As this perspective deals with closing the gap between the current IT infrastructure and desired direction of IT, a fitting objective is **Make IT sustainable.** This objective deals with actively working to make IT sustain itself, by minimizing resources and energy consumption to allow for continuous use of IT, in both the present and the future environment. In addition, this objective would answer to the political pressures in Sweden to become a sustainable company. The authors would argue that all of the initiatives that have been found contribute to this objective through resource minimization, reduced energy consumption, better management of IT assets, as well as educating staff in how to become sustainable with IT.

This leads into the second objective for this perspective, **Improve employee awareness of Green IT**. By educating the staff in the meaning of Green IT, and how to manage new green processes and devices, skills to sustain the company into the future will be developed. The initiative *Educate staff within Green IT* will aid this objective.

The final objective in the Employee Learning and Growth Processes perspective is to **Implement environmental management system** with the initiative to *Become certified by ISO 14001, or the like.* The authors saw that this objective can help in achieving all of the other objectives in the Green IT Balanced Scorecard by providing a way of measuring and controlling resource utilization as well as managing human capital knowledge.

To conclude the analysis above, the Green IT Balanced Scorecard is presented below in figure 5.1.

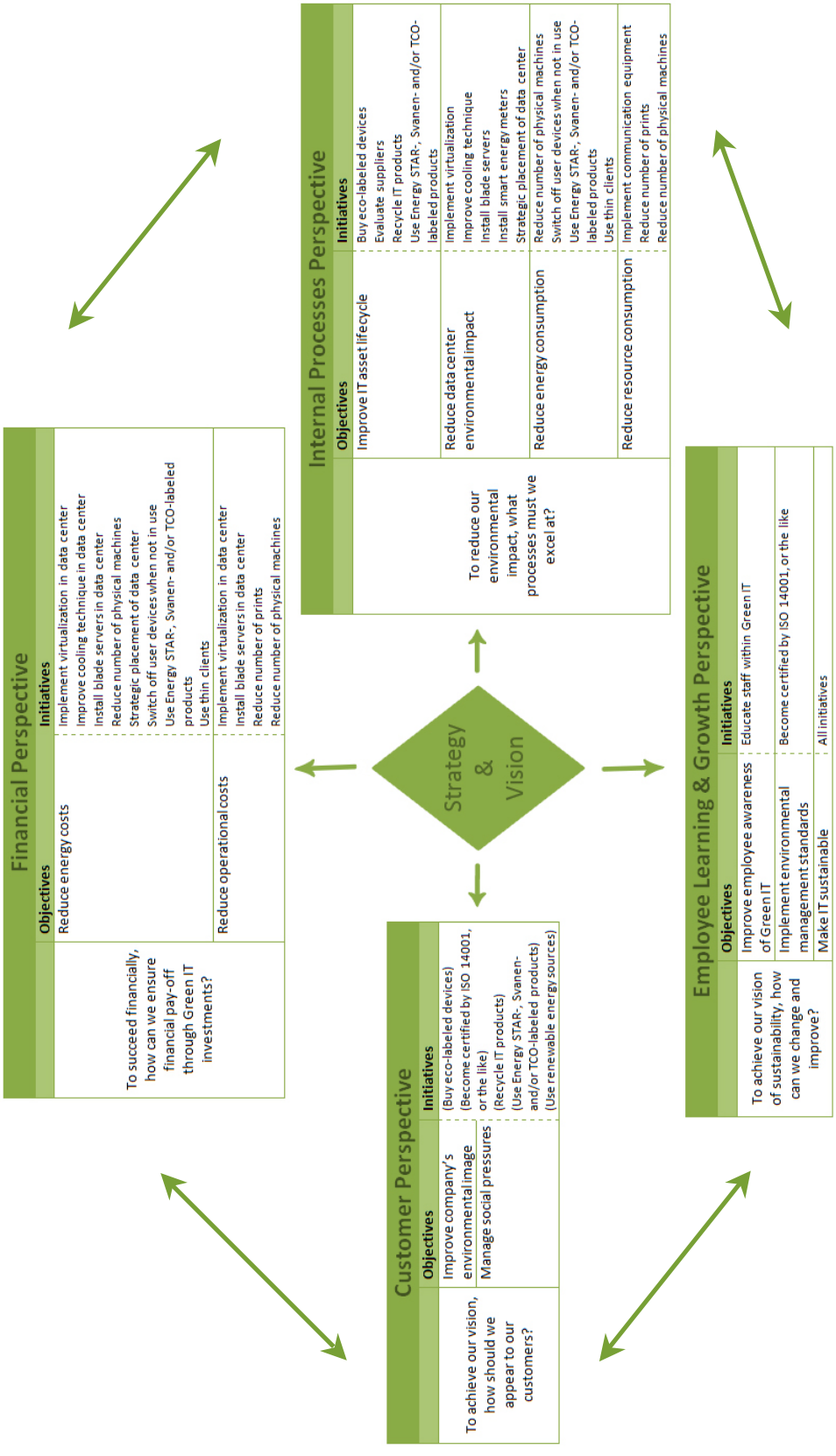

Figure 5.1 The Green IT Balanced Scorecard

6 Conclusion

This section will present the conclusion of the study by answering the research question and satisfying the purpose of the thesis.

Initially, it was seen that several pieces of research on Green IT in the Swedish environment had been conducted. However, none of these studies produced objectives or guidelines on how to implement the most general trends of Green IT practices in Sweden. The authors saw the need to produce objectives for the implementation of Green IT, using a model that could easily be followed and comprehensible enough to allow for a successful implementation. Therefore, the Balanced Scorecard model was used to find objectives and initiatives of Green IT in all areas of the organization.

The research question for this thesis asks whether or not the Balanced Scorecard model has to be adapted and can be used to create objectives for the implementation of Green IT. The authors found that the model did not have to be adapted when using it for Green IT strategies in sense of adding, or removing, any perspectives. The original four perspectives were therefore used: financial, internal processes, customer and employee learning and growth. However, the original model was adapted with new perspective questions that better fit the new content of the Green IT Balanced Scorecard.

The authors also saw that the model could provide guidelines, in the form of objectives that could be used for implementing Green IT into a Swedish organization. In addition, by using the Balanced Scorecard model, the different perspectives allowed the entire organization to be addressed in the implementation of Green IT, not just the technical side of the organization.

7 Discussion

This section discusses the strengths and weaknesses of the results of the thesis and the research methodology chosen. In addition, the research contribution, the practice implications of this thesis and suggestions for future research will be discussed.

This research has resulted in the finding of many different Green IT practices that are actively used in several parts of the organization. More practices than expected were found that contributed to a more comprehensive view of Green IT in the final Green IT Balanced Scorecard model. In addition, several Green IT drivers were also established by the authors that had not been looked for intentionally in the beginning of the research. These drivers proved useful in establishing whether or not the Balanced Scorecard model had to be adapted to a Green IT strategy. Also, the drivers showed that, in Sweden, similar needs had pushed the implementation of Green IT forward, due to similarities in the drivers that were found between the interviewed companies.

However, the results may have been affected by the fact that the interview with Company D was not made face-to-face, limiting the answers received from this company. In addition, all of the other interviews were held with the head of the IT department, or someone with a high position in the organization that had actively worked with the implementation of Green IT. The interview with company D was conducted with an employee outside the IT department and may therefore not have resulted in the correct or sufficient answers regarding the IT equipment used.

Also, another limitation to the empirical findings is the fact that company B has no control over their own data center due to the fact that they are renting space in Company C's data center. This limits Company B's ability to affect what the structure and operation of the data center itself, for example cooling techniques and location.

A final limitation to the thesis results is low response rate from the companies that were asked to participate in this thesis. A total of seven companies were asked to participate in thesis and six of them agreed to be interviewed. However, only four of the companies were interviewed and the rest opted out right before the interview, for different reasons, causing difficulties in finding new companies in time.

In addition to the results that have been presented, the authors found several practices that were considered to be green by the Swedish companies, but could not be proven in the scientific environment. Therefore, these were not included in the analysis, but two of them the authors found to be of significant importance. The first would be the introduction of a "reduce email campaign", that was held at Company B, to reduce the amount of stored data on the servers and thus reducing the need for an extra server. Also, another practice that was found was buying unpackaged hardware. Company A did this to the best extent that they could, however, they mentioned that it was very difficult to get the suppliers to send unpackaged hardware and it was also usually more expensive. However, the authors see that buying unpackaged will both save resources as well as money in recycling.

The inductive method that was chosen can in hindsight be seen as the best practice because the Green IT drivers that were found would most likely not have been found if the deductive approach was used. With the deductive approach, the focus would mostly have been put on only matching the practices with the already established Green IT Balanced Scorecard, thus missing the drivers.

The authors realize that a drawback of the method chosen for establishing an IT practice and driver as Green, can be seen as limited, due to the fact that only three sources had to mention the practice or driver in order to establish it in the scientific environment. However, due to time and resource limitations this limitation had to be set to ensure the completion of the thesis.

Also, the use of semi-structured interviews was positive as it brought attention to several IT practices that had not been thought of prior to the interviews. However, this type of interview structure also caused the results to be slightly imprecise because new practices that were found in the later interviews were not confirmed with the first interviewed companies.

The contribution of this thesis, to the practical society, is that a Green IT Balanced Scorecard has been created and can be used to both aid in the new implementation of Green IT or in further improvement of it. The Green IT Balanced Scorecard can be used in practice as guidelines for the implementation and give examples of what initiatives are most typical for the Swedish environment. In addition, the implementation of Green IT in a company can aid in reducing resource and energy use, as well as help the organization comply with government regulations.

The contribution of this thesis, for further research is, that several Green IT practices for the Swedish environment are found and established and also the Green IT Balanced Scorecard can be used as a basis for further research within this field in Sweden. Suggestions for future research on this topic is to find measures that can be included in the Green IT Balanced Scorecard and aid a company to evaluate the success of its implementation of Green IT. Also, future research could test how well the Green IT Balanced Scorecard aids in the implementation of Green IT practices in the Swedish environment. Lastly, a more comprehensive research, including more companies and industries in Sweden, could ensure a more generalizable model.

List of references

Aasvold, W. & Nilsson, A. (2010). *Grön IT - en fallstudie av de viktigaste satsningarna inom Grön IT hos organisationer i IT-branschen*. Luleå, Sweden: Luleå Tekniska Universitet.

Behringer, W. (2007). *A Cultural History of Climate*. München, Germany: Verlag C. H. Beck oHG.

Brundin S. (2011, October 12). Tio tekniker som gör datacentret grönare. *IDG.se*. Retrieved April 24, 2012, from http://www.idg.se/2.1085/1.409241/tio-tekniker-som-gor-datacentret-gronare

Broberg, E. (2009). *Grön IT- Motiv, åtgärder & tillvägagångssätt för hållbara IT-lösningar*. Sweden: Mälardalens Högskola.

Brown, C. V., DeHayes, D.W., Hoffer, J. A., Martin, E. W., & Perkins, W. C. (2009) *Managing Information Technology* (6th ed.). New Jersey, USA: Pearson Education, Inc.

Dunlap, R. E., Van Liere, K. D., Mertig, A. G., & Emmet Jones, R. (2000). Measuring Endorsement of the New Ecological Paradigm: A Revised NEP Scale. *Journal of Social Issues, 56*(3), 425-442.

Dunphy, D. (2011). Conceptualizing Sustainability: The Business Opportunity. In G. Eweje & M. Perry (Ed.), *Critical Studies on Corporate Responsibility, Governance and Sustainability* (Vol. 3) (p. 3-24). Bingley, UK: Emerald Group Publishing Limited.

Gore, A. (2006). *An Inconvenient Truth - The Planetary Emergency of Global Warming and What We Can Do About It*. New York, USA: Rodale.

Earth Hour (2012a). *About Page*. Retrieved April 10, 2012, from http://www.earthhour.org/page/about/about-earth-hour

Earth Hour (2012b, April 1). *Biggest Earth Hour Ever Begins The Journey Across The Globe*. Retrieved April 10, 2012, from http://earthhour.org/blog/biggest-earth-hour-ever-begins-journey-across-globe

Frennesson, M., & Gustavsson, E. (2008). *Grön IT: Energibesparingar i datacenters med fokus på bladteknik, visualisering och kylning*. Kalmar, Sweden: Högskolan i Kalmar.

Hansson, J. (2011). *Snabbare ökning av förnybar energi*. Retrieved April 17, 2012, from http://energimyndigheten.se/sv/Press/Nyheter/Snabbare-okning-av-fornybar-energi/

Hewlett-Packard Development Company. (2011). *Hur väljer jag grönt it?* Retrieved February 29, 2012, from http://h41112.www4.hp.com/promo/obc/se/sv/how-to-choose/technology-explained-hardware/how-to-choose-green-it.html

Jain, R. P, Benbunan-Fich, R., & Mohan, K. (2011). Assessing Green IT Initiatives Using the Balanced Scorecard. *IT Professional*, January/Febuary, 26-32.

Jönköping Energi AB (2012). *100% förnybar el*. Retrieved April 17, 2012, from https://www.jonkopingenergi.se/el/el-och-miljo/100-fornybar-el

Kaplan, R. S., & Norton, D. P. (1992). The Balanced Scorecard - Measures That Drive Performance. *Harvard Business Review, 70*(1), 71-79.

Kaplan, R. S., & Norton, D. P. (1996a). Linking the balanced scorecard to strategy. *California Management Review, 39*(1), 53-79.

Kaplan, R. S., & Norton, D. P. (1996b). Using the Balanced Scorecard as a Strategic Management System. *Harvard Business Review, 74*(1), 75-85.

Kristiansson, E. (2008). *Green IT- What does it take for Scania InfoMate to become a Green IT solution provider?* Borås, Sweden: Högskolan i Borås.

Lamb, J. (2009). *The Greening of IT: How Companies Can Make A Difference For The Environment.* Michigan, USA: IBM Press/Pearson Plc.

Milbrath, L. W. (1984). *Environmentalists: Vanguard for a new society.* Albany, NY, USA: State University of New York Press.

Miljömärkning Sverige Ab. (2012). *Varför miljömärkt?*. Retrieved May 30, 2012, from http://www.svanen.se/konsument/varfor/

Murugesan, S. (2008). Harnessing Green IT: Principles and Practices. *IT Professional*, January/February, 24-33.

Murugesan, S. (2010). Making IT Green. *IT Professional*, March/April, 4-5.

Nidumolu R., Prahalad, C. K., & Rangaswami, M. R. (2009) Why Sustainability Is Now The Key Driver of Innovation. *Harvard Business Review*, *89*(9), 56-64.

Niven, P. R. (2005). *Balanced Scorecard Diagnostics.* Hoboken, N.J, USA: J. Wiley & Sons.

Niven, P. R. (2007) IT Performance Management Using the Balanced Scorecard. In J. Stenzel (Ed.), *CIO Best Practices: Enabling Strategic Value with Information Technology* (pp. 185-221). Hoboken, N.J, USA: J. Wiley & Sons.

Norström, J. (2009). *IT-utrustnings miljöeffektivitet - En undersökning av Grön IT på Umeå Energi.* Umeå, Sweden: Umeå Universitet.

Olve, N-G., & Sjöstrand, A. (2006). *Balanced Scorecard.* West Sussex, UK: Capstone Publishing Ltd.

Olve, N-G., Petri, C-J., Roy, J., & Roy, S. (2003). *Framgångsrikt styrkortsarbete - Metoder och erfarenheter.* Malmö, Sweden: Liber Ekonomi.

Pearlson, K. E., & Saunders, C. S. (2009). *Strategic Management of Information Systems* (4th ed.). Asia: John Wiley & Sons Pte Ltd.

Penna, A. N. (2010). *The Human Footprint : a global environmental history.* Oxford, UK: Wiley-Blackwell.

Puelma, R., Huynh, V., & Negasi, Y. (2008). *Grön IT: IT med miljöhänsyn.* Jönköping, Sweden: Högskolan i Jönköping.

Regeringskansliet (2012). *Grön it.* Retrieved April 26, 2012, from http://www.regeringen.se/sb/d/12886

Saunders, M., Lewis, P., & Thornhill, A. (2009). *Research methods for business students* (5 ed.). Essex, UK: Pearson Education Limited.

Sundblad, Y., Lind T., & Rudling J. (2002). *IT product requirements and certification from the users' perspective*. Department of Numerical Analysis and Computer Sciences, KTH. Retrieved 25 april 2012 from address http://cid.nada.kth.se/pdf/CID-176.pdf

Sveriges Riksdag (2012). *Miljöbalk (1998:808)*. Retrieved April 26, 2012, from http://www.riksdagen.se/sv/Dokument-Lagar/Lagar/Svenskforfattningssamling/Miljobalk-1998808_sfs-1998-808/

Tomlinson, B. (2010). *Greening through IT*. USA: MIT Press.

Unhelkar, B. (2011a). *Green IT Strategies and Applications - using environmental intelligence*. Boka Raton, FL, USA: Taylor adn Francis Group, LLC.

Unhelkar, B. (2011b). Green IT - The Next Five Years. *IEEE Computer Society, IT Pro*, *March/April 2011*, 56-59.

United Nations Framework Convention on Climate Change. (2012). *Kyoto Protocol*. Retrieved February 10, 2012, from http://unfccc.int/kyoto_protocol/items/2830.php

Wikberg, J. (2008, June 18). Grön IT policy blir ofta fiasko för svenska företag. *IDG.se*. Retrieved February 29, 2012, from http://www.idg.se/2.1085/1.166188

Yin, R. K. (2003). *Case Study Research : Design and Methods* (3 ed.). California, USA: Sage Publications, Inc.

Appendix I – Interview questions

1. How do you use IT to reduce your environmental impact? By:
    a. Turning off computers when not in use
    b. Energy-efficient data centers
        i. Strategic positioning of data centers to reduce energy consumption, considering, for example, cooling
        ii. Visualization of data centers
    c. Printing policies
    d. Recycling of IT products
    e. Customized systems for keeping track of CO2 emissions from, for example, transports or energy to department stores
    f. Web conferences instead of traveling
    g. Reduction of unnecessary email-communication and inbox memory per user
2. What goals did you have when implementing your current "green" IT solutions?
    a. How did you measure your success? Did you use any specific measures? For example, ROI or lower energy consumption.
    b. Did you have any challenges with the implementation or planning of these IT solutions?
    c. Do you have any future goals for Green IT?
3. Do you have any specific "Green IT" policies, or policies about being energy efficient?
4. When purchasing, for example, computers, do you consider the computers' environmental impact? For example, computers with Energy STAR labeling or eco-labeled suppliers?
5. Does your customers/suppliers require your IS/IT to be eco-friendly?
6. Do you market your company as a "green" company to improve your image?
7. Is your company eco-labeled or certified in any way?
8. Have you communicated any "green" ideas, or information about Green IT, to your employees?
9. Have you educated your staff in Green IT?
10. In what aspects have you seen improvements relating to your green IT solutions?
    a. Lower energy consumption
    b. Higher customer satisfaction
    c. Improved image
    d. Increased profits
    e. Co2 reductions

Appendix 2 – Green IT Practices matrix

Green IT Practices / Sources	Blade servers	Buying eco-labeled devices	Buying unpackaged	Communication equipment	DC fans	Distance control	Document management system	Eco-friendly extinguishing fluid	Effective printer standards
Authors									
Frennesson & Gustavsson	●								
HP (2011)		●							
Kristiansson (2008)									●
Murugesan (2008)		●							
Sveriges Riksdag (2012)		●							
Tomlinson (2010)		●					●		
Unhelkar (2011a)		●		●					●
Unhelkar (2011b)									●
Companies									
Company A	●	●	●	●	●			●	●
Company B	●	●		●	●		●		●
Company C	●	●		●		●	○		●
Company D		●		●		●			●

Green IT Practices / Sources	E-invoices	Energy STAR	ISO 14001 certification	Evaluating suppliers	Free cooling	Green IT education	Hot-aisle-cold-isle server placement	Other energy efficient hardware	PUE numbers	Recycling
Authors										
Brundin (2011)					●					
HP (2011)		●		●						●
Murugesan (2008)		●		●		●				
Murugesan (2010)						●				●
Nidumolu et al. (2009)						●				
Tomlinson (2010)									●	
Unhelkar (2011a)		●	●				●			●
Unhelkar (2011b)						●				●
Companies										
Company A	●		●	●	●	●	●	●	●	●
Company B			●							
Company C						○				●

Green IT Practices / Sources	Reduce and limit email storage	Remote shut-down of computers	Renewable energy sources	Smart energy meters	Strategic placement of data centers	Svanen	Switching off devices not in use	UPS with high efficiency	TCO	Thin clients	Virtualization
Authors											
Frennesson & Gustavsson (2008)										●	●
Hansson (2011)			●								
Jain et al. (2011)											●
Murugesan (2008)		●			●		●			●	●
Sundblad et al. (2002)									●		
Tomlinson (2010)			●	●							
Unhelkar (2011a)			●	●	●		●			●	
Unhelkar (2011b)		●					●				●
Companies											
Company A			●	●			●	●			●
Company B	●	○	●	●						○	●
Company C	●		●	●			●		●	○	●

Appendix 3 – Green IT Drivers matrix

Drivers of Green IT / Sources	Competitive advantage	Cost savings	Resource minimization	Survive	Sustainability
Authors					
Kristiansson (2008)			●		
Lamb (2009)	●		●		
Murugesan (2008)	●	●	●		
Murugesan (2010)				●	
Nidumolu et al. (2009)	●	●			●
Sveriges Riksdag (2012)					●
Unhelkar (2011a)	●	●	●	●	
Companies					
Company A	●	●	●		●
Company B		●	●	●	
Company C			●	●	
Company D	●		●		●