Does EU environment policy influence hospitals and public health?

Good practices of hospitals with improved energy performance

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Abstract

Introduction: The topic of this thesis is the possible influence of EU environment policy on health and hospitals. The health impact is analysed based on a study by Holland (2008), arguing for a reduced morbidity and mortality through reductions in greenhouse gas emissions.

Methods: The influence on hospitals is analysed through a review of literature and documents on EU environment policy, based on the 6th environment action programme, investigating if and how hospitals are mentioned or implicitely affected by the measures. The second part of the thesis identifies good practices among hospitals with an improved their energy performance as examples of this interaction between environment and health policies.

Results: As in the 6th environment action programme, EU environment policy can be categorized into four priority areas, namely climate change and energy, nature and biodiversity, environment and health and quality of life, and natural resources and waste. In addition, environmental certification schemes can be utilized by hospitals. The influence of many of these policies on hospitals cannot be predicted or recognized because of the dependence on national implementation. Health is positively influenced by environment policies, as aimed for in the Treaty of the European Union, through reductions in greenhouse gas emissions.
Examples of proactive engagement in environmental performance are hospitals who have improved their energy consumption by either saving energy or changing to renewable resources. These good practices can be found all over Europe and can be classified in improved building efficiency, installation of energy-saving equipment, training of staff, training of patients, installation of a combined heat and power plant, energy-saving transport, and using geothermal energy, biomass, solar, wind and hydropower.

Discussion and Conclusion: The limited time and space of the thesis did not give the possibility to scientifically analyse the reasons for hospitals to change their energy consumption. It can be seen that environment policy has an influence on hospitals, though often depending on national implementation. The same dependence has been observed for the health impact, but the overarching aim of improving health through environment policy is met by the policy, and the national implementation influences only the scope.

Foreword

This thesis has been written in the time between February and June 2009 at the European Hospital and Healthcare Federation (HOPE) in Brussels. The topic of the thesis was suggested by Pascal Garel and deals with the possible influence of environment policies on health and hospitals. The empirical study I conducted to find good practices of hospitals related to energy consumption was only possible because I was able to use HOPE's network in the member organisations.

Pascal Garel was the responsible supervisor at HOPE and I would like to express my gratefulness for this opportunity to stay at HOPE and for his support and advice throughout the whole research process.

I also thank Carolien Bastiaenen, PhD and Leo Schouten, MD, PhD for their scientific supervision before and during my research.

List of abbreviations

CHP	Combined Heat and Power
CO_2	Carbon Dioxide
DG	Directorate General
EAP	Environment Action Programme
EMAS	Eco-Management and Audit Scheme
ETS	Emissions Trading Scheme
EU	European Union
HOPE	European Hospital and Healthcare Federation
IPPC	Integrated Pollution Prevention and Control
ISO	International Organization for Standardization
kW	Kilowatt
kWh	Kilowatt hours
MWh	Megawatt hours
ROC	Renewable Obligation Certificate
UK	United Kingdom
WEEE	Waste of electrical and electronic equipment
WHO	World Health Organization

Introduction

The subject of this Bachelor thesis will be European Union (EU) environment policy and its possible influence on hospitals and health. As an illustration of the interaction of hospitals and the environment, and an example of self-regulation, the thesis analyses good practices among hospitals in Europe with regard to improved energy performance.

The environment, and thus environment policy, is an important topic for public health, as has been recognised in Article 174 of the Treaty establishing the European Community, stating that Community environment policy shall contribute to the protection of human health. Complementary to Article 174, Article 152 provides for the inclusion of health in all policies, of course including environment policies. (Consolidated Version of the Treaty establishing the European Community, 2002) The introduction of Ministerial Conferences on Environment and Health in 1989 marks an important step in the rapidly evolving agenda on intersectoral action between the environment and health (Martuzzi, 2006), also included in the Sixth Environment Action Programme, which "aims at a high level of protection of the environment and human health and at a general improvement in the environment and quality of life" (Decision No 1600/2002/EC, 2002, p.1).

An interaction between the two policy areas is also encouraged by the limited competences in health care policies of the EU. This limitation induces indirect influences on hospital policies through broader policy areas, such as environmental policy. (Mossialos & McKee, 2002) Environment policy can have an impact on different areas of hospital affairs. Therefore, an overview of all priority areas of EU environmental policy will be given to be able to identify its possible influence on hospitals and public health before concentrating on energy for the identification of good practices among hospitals.

Enforced action to reduce energy consumption, and thus also greenhouse gas emissions, is important because since 1999, emissions have risen due to rapidly increasing demand for electricity in the EU, after a period of decreasing greenhouse gas emissions per unit of energy consumption in the 1990s thanks to the trend to change from traditional means of energy production towards the use of renewable resources. (EEA, 2008) Energy production and consumption can make a difference on emissions of health-threatening gases, since they make

up about 80% of total greenhouse gas emissions (EEA, 2008). According to the EU Eco-label (2002), environmentally friendly public energy purchases would cause a reduction by 60 million tonnes of carbon dioxide (CO_2) in Europe, which accounts for 18% of the EU's greenhouse gas reduction commitment under the Kyoto Protocol. Hospitals can contribute to these reductions through conscious decisions about their energy policy.

The scarcity of many energy resources makes new technologies that save energy an important tool to create sustainable energy provision. Since a constant supply of energy is essential to the provision of high-quality and high-technology health care, saving energy to ensure sustainable supply does not compromise, but maintain, the quality of health care provision. In addition, decreased spending on energy means that a larger part of the budget can be invested in health care provision (Kralj & Pivec, 2007) In industrialized countries, including many European countries, who have experienced a large increase in health care expenditures during the past four decades (McKee, Healy, Edwards & Harrison, 2002), saving energy is therefore an important tool to slow the growth of costs without impairing the provision of patient care.

Best practices can be defined as “a process-oriented concept to achieve improvements within individual agencies or settings over time” (Perleth, Jakubowski & Busse, 2001, p.237). This concept is related to the quality of a process, which is improved and therefore leads to better performance. Best practices can be used by other organisations to improve their performance, and are therefore seen as benchmarks which organisations in a field try to achieve. (Perleth, Jakubowski & Busse, 2001)

For this thesis, hospitals constitute good practices if they have introduced measures to change their energy consumption leading to reduced greenhouse gas emissions, which according to the literature positively influences health. Measures that are good practices are improving energy efficiency, changing energy production to renewable resources or taking both actions. Both saving energy and using renewable resources have implications for environmental and human health through the reduction of emissions.

The structure of the thesis will be that in the first chapter the methods of the research are outlined. To provide the theoretical background of the approach, a study is presented in chapter two which identifies the health benefits of policies that reduce greenhouse gas emissions, and the European 6th Environment Action Programme is introduced which will

provide the structure for analysis. The third chapter of the thesis will analyse EU environmental policy according to the structure of the Environment Action Programme, to the health benefits of the policy and its influence on hospitals. The thesis will in the fourth chapter identify good practices among European hospitals with regard to pro-active engagement in improving energy performance, before closing with a discussion and a conclusion.

Chapter 1 – Theoretical background

There is lack of a specific theory that can be used as the basis of this thesis, the aim of which is to identify the impacts on health and on hospitals of EU environmental policy. That is why the theoretical background will be made up of two documents, providing the scientific background for argumentation on the one hand, and the structure for the paper on the other.

The scientific background of the following analysis is provided by a study of the Health and Environment Alliance, the Climate Action Network and World Wildlife Found Europe (Holland, 2008) which identifies the benefits to health of a reduction in greenhouse gas emissions. The methods used for this study have been developed by the European Commission Directorate General for Environment under the Clean Air for Europe programme and have been subject to peer review. The health effects of the pollutants $PM_{2.5}$ (fine particles), SO_2 (Sulphur dioxide) and NO_X (Nitrate oxide) are respiratory illnesses, like bronchitis and asthma, cardiac and respiratory hospital admissions and higher death rates. The study uses European Commission data on impacts of health pollution to outline the health impacts of not changing emissions, changing them by 20% and of changing greenhouse gas emissions by 30%. As an example, it is shown that the health impact of not changing emissions is 2,800,000 life years lost in 2020. A 20% cut in greenhouse gas emissions would reduce this number by 218,182 life years, and a 30% cut by 323,333 life years. These numbers show clearly that a reduction in greenhouse gas emissions has a significant positive effect on human health.

The methods for decreasing emissions of greenhouse gases are to reduce the consumption of resources that release these gases when incinerated. The consumption of those, mostly fossil fuels can be decreased through a reduction in consumption of energy produced by these fuels. This reduction can be achieved by using resources that do not release greenhouse gases instead of fossil fuels, or by reducing energy consumption in general. As energy production and consumption contribute about 80% of greenhouse gas emissions, measures to reduce them will have a large impact on emissions and thus on health. (EEA, 2008)

The Commission's 6th Environment Action Programme (EAP) (European Commission, 2002) provides the frame to current European environment policy and will therefore be used in this

thesis to provide the structure of the environment policy analysis. It divides environmental policy of the EU into four priority areas, namely climate change, nature and biodiversity, environment and health and quality of life, and natural resources and waste. This thesis aims to give an overview of EU environment policy, but a large focus is put on the climate change area of the EAP, and within that area special attention will be paid to energy policy, because the focus of the thesis is on energy policies of hospitals.

1.1 Research questions

1. What is the current European Union policy for environment?
    a. What is the impact of environment policy on health?
    b. What is the impact of environment policy on hospitals?
2. Which hospitals constitute examples of good practices in terms of the use of energy and what measures do they take to improve energy performance?
    a. In what context do the hospitals operate?

Chapter 2 - Methods

The research for this thesis has been done in a qualitative way, using two methods for the two parts. The literature and document review about EU environment policies and how these affect hospitals provides the context and background for the development of the questionnaire and interview for the identification of good practices among hospitals, and gives the researcher information to be used during the interviews. (Lie, n.d.) The research uses a cross-sectional design, as it concentrates on data collection at one point in time, and constitutes a collective case study, which is a case study with more than one case of analysis (Stake, 2000).

The first part of the thesis is based on a document and literature review about EU environment policy. The aim of this document and literature review was to answer the following research questions: What is the current EU policy on environment? What is the impact of EU environmental policy on health? What is the impact of EU policy on hospitals? It is based on the theoretical framework in its structure, which follows the 6th EAP (European Commission, 2002), and its analysis of health impacts which is based on Holland's (2008) study on health effects of reducing greenhouse gas emissions.

For the literature and document review the researcher browsed the website of the European Commission. Especially the sites of the Directorate General (DG) for Environment and of DG Energy were relevant for the research. Search criteria were 'environment policy', 'climate change' and 'energy'. As a start, comprehensive documents such as "The sixth Environment Action Programme" (European Commission, 2002) and "European environment and health strategy" (European Commission, 2005) were read to get an overview and to find references of relevant documents. This search delivered 79 documents. The documents were included according to the criteria that they have an impact on hospitals and that they fit into one of the categories of the 6th EAP, which was chosen as the structure of this part of the thesis. This exclusion process of documents that did not meet the inclusion criteria left the researcher with 47 documents to be analysed. Of these, document summary sheets were written, which provide the most important information in order to reduce the amount of data. In order to analyse the material, the theoretical frame was used, namely the 6th EAP. This programme provided the codes for analysis according to which the data was reviewed. These analytical categories were assembled into a matrix and allocated to the passages in the text, which was

the actual coding process (Schmidt, 2004). This led to the filling of the matrix with passages from the text according to the codes. The codes used in this process were the four priority areas of the 6th EAP climate change, environment and health and quality of life, nature and biodiversity, and natural resources and waste. The columns of the matrix included the codes named aim of policy, content of policy, health impact, and impact on hospitals.

For the second part, an open questionnaire (Annex A) has been distributed among European hospitals that are engaging in pro-active behaviour regarding energy consumption. Supporting the questionnaires, semi-structured interviews have been conducted and a literature and document review has provided additional information on the chosen hospitals. The sampling frame for this survey is all members of HOPE, which are national hospital associations, health care authorities or regional authorities, the population of interest being all hospitals within these members that have already engaged in activities to improve energy performance. The sampling has been done through reputational case selection, meaning that the national members were contacted and identified hospitals in their countries which have initiated action to improve energy performance. A limitation of this approach was that some of the national contacts did not reply to the researcher, naming relevant persons, but directly distributed her questionnaire to relevant hospitals. Therefore, the researcher did not know the exact number of distributed questionnaires and thus also did not know how many questionnaires to expect in return.

The sample of hospitals that have been identified by the national contacts as examples for improved energy performance were contacted and asked to complete a questionnaire (Annex A). This questionnaire was developed by the researcher with support of her supervisor at Hope, and included open and closed questions about the kind of actions taken by the hospitals, their motivation and funding of actions. In the first step of the descriptive analysis, only three questions have been included (question 3a, 4b and 6b). These were the questions that indicated what specific action the hospital has taken. This analysis led to the selection of the cases that are included in the final analysis. The sampling criteria of the selection were to find an example of all the different ways to improve energy performance, and to find a large variety in terms of the hospitals' contexts. After reaching saturation of the first criterion, by having received a questionnaire from hospitals with all the different possibilities to improve energy consumption, the researcher has contacted the selected cases for a semi-structured interview via the phone to get a deeper understanding of the motivations and the actions

taken. The interviews took between 8 and 40 minutes. This large difference resulted from differences in information given in the questionnaire, and from a differing level of complexity and difficulty to understand the hospital's actions to improve energy performance. Before the questions about energy consumption (see Annex B for an overview about interviews), the researcher introduced herself and explained that the interview is used as a data source in addition to the data in the questionnaire. The interviewees were asked for permission to tape-record the interview and to store the data digitally, as well as to contact the person again in case there are additional questions that needed to be addressed. Before conducting the interviews with hospitals, a pre-test interview with the host supervisor was done.

The further descriptive analysis of both the questionnaire and the interviews had the aim of answering the research questions: What measures the hospitals take to reduce energy consumption and in what context they operate. The context in this case means the motivation of the hospital to save energy and the difficulties and support they have experienced in their actions. The definition of good practices in hospital energy performance is based on the positive relationship between consumption of fossil fuels and greenhouse gas emissions (EEA, 2008) and on the study by Holland (2008), which proves health gains due to reduced greenhouse gas emissions.

Chapter 3 – EU environment policy

To give an introduction to EU policy, the different forms of policies are explained first. EU policy consists of primary and secondary legislation. Primary legislation is made up of the Treaties, the Nice consolidated version of the Treaty of the European Community (2002) being the latest ratified version. The Lisbon Treaty, agreed upon in 2007, is not ratified by all EU member states and thus not in force. Based on primary legislation, secondary legislation in the EU consists of laws that enforce the provisions of the Treaties in two ways: either as a regulation, meaning that the European law is directly translated into national law, or as a directive which is not directly implemented as national legislation, but is introduced in an adapted form. In addition to primary and secondary legislation, the EU institutions produce legally non-binding documents, such as recommendations, communications, declarations and action plans. The latter one of these provides information about a topic of interest and outlines priorities for action, based on which secondary legislation can be introduced. (Kent, 2008)

This paper focuses on EU environment policies, which will be analysed in three steps: their content and aims, how they affect hospitals, and their influence on health. Due to the broad and non-binding nature of the European action programmes, declarations and strategies, the analysis of the influence on hospitals and health will be limited to binding, legislative documents. After the analysis of policies according to the structure of the 6th Environmental Action Programme, three European environmental certification schemes will be described as they can be utilised by hospitals.

EU environmental policy is based on *Article 174* of the consolidated version of the Treaty of the European Community (2002). The provisions in this article clearly show the link between environment and health, stating in the objectives of Community environment policy that it should protect human health. In order to do so, environment policy should preserve, protect and improve the quality of the environment and encourage a thoughtful production and use of natural resources.

A framework for the direction of policies is given by the *EU Environment Action Programme* (EAP). The 6th EAP, ranging from 2002 until 2012, lays down four key areas of action, namely climate change, nature and biodiversity, environment and health and quality of life, and natural resources and waste (Decision No 1600/2002/EC, 2002). Not only can the impact

of environment on health clearly be seen again in the definition of the key action areas, but they also provide the structure of this part of the thesis. The 6th EAP calls for development of thematic strategies in the four key areas which set out action to be taken to tackle the environmental area.

3.1 Climate change and energy

The first priority area of the 6th EAP is climate change, which is to be tackled by meeting the emission cuts set out by the Kyoto protocol of 8% until 2012 compared to 1990 levels. In addition, European climate change policy should advocate an international agreement with more stringent emission reduction goals. (Decision No 1600/2002/EC, 2002)

The European Commission has issued an energy and climate change package in January 2008 named *"20 20 by 2020 – Europe's climate change opportunity"* which commits the member states of the EU to a reduction in greenhouse gas emissions of 20% by the year 2020, compared to 1990 levels. In case of an international agreement which binds other countries to reductions in their emissions, this target will be increased to 30%. The second goal is to increase the share of renewable resources in the EU to 20%. To reach this, a directive (Directive 2009/28/EC, 2009) on the promotion of the use of energy from renewable resources has been adopted. Further strategies to reach the emission cuts are a revision of the Emissions Trading System reducing emissions not covered by this system by 10%, energy efficiency increases and boosting carbon capture and storage technology (European Commission, 2008d).

3.1.1 Climate change

The EU has established national emissions ceilings for certain atmospheric pollutants by means of *Directive 2001/81/EC* (2001). It applies to the release of sulphur dioxide, nitrogen oxides, volatile organic compounds and ammonium into the atmosphere. The emissions ceilings are expressed in kilotonnes, and shall be complied with by member states in the year 2010 at the latest. In order to achieve this emission reduction, by October 2002 member states are required to set up national programmes to progressively decrease their emissions.

The directive does not provide requirements on how member states' programmes should be organised, nor is it clear what the impact of the directive on hospitals is. The impact on health, on the other hand, is clearly visible because a reduction of pollutant emissions leads to

improved health by decreasing the incidence of premature deaths, asthma attacks, restricted activity days and other morbidities such as chronic respiratory disease (Holland, 2008).

Apart from national emissions ceilings, the EU pursues its aim of cutting emissions through an emissions trading scheme (ETS). The ETS has been established by *Directive 2003/87/EC* (2003) with the aim of reducing member states' emissions in line with the targets under the Kyoto protocol and covers combustion plants, oil refineries, coke ovens, iron and steel plants, and certain production factories. By restricting the number of national allowances, the market creates a price for additional greenhouse gas emissions. If this price is higher than the costs for investment in energy savings it will consequently lead organisations to invest in energy savings. Hospitals have been affected by the revision of the scheme because of the on-site production of electricity, leading the hospital to exceed the threshold for exempted small emitters due to the presence of emergency generators and boilers (Cook, 2008). The proposal amending Directive 2003/87/EC has been adopted with amendments by the European Parliament in December 2008 introducing a clause that member states may exclude hospitals from the ETS if these hospitals participate in national schemes to reduce carbon emissions (European Parliament, 2008).

In January 2008, the European pollution prevention and control directive 96/61/EC and its several amendments have been recast to be integrated into *Directive 2008/1/EC* concerning integrated pollution prevention and control (IPPC) (2008). The aim of this integrated approach is preventing or minimising the pollution of air, water and soil and thereby achieving the protection of the environment. The recast of this directive was to include "combustion installations with a rated thermal input exceeding 50 MW" (Directive 2008/1/EC, Annex 1, p. 0019), which would have applied to many hospitals with large boiler capacities for emergencies and power failures. This inclusion of hospitals into the integrated pollution prevention and control scheme would have produced high additional costs for them, or would have meant a compromise in safety of energy supply due to the reduction of boiler capacities for the sake of saving money. In March 2009, Parliament has amended Directive 2008/1/EC by including an exemption from the provisions for hospitals. This amendment would mean that in hospitals, only the regular running capacity of combustion plants is taken into account for the calculation of capacities and not the stand-by capacities that are not regularly used. (European Parliament, 2009) Due to the provisions of the co-decision

procedure, Parliament's amendments have to be agreed upon by the Council of the European Union before they are final.

The costly influence on hospitals of the IPPC Directive could, thanks to the exemption, be prevented if the Council adopts the changes. The IPPC scheme still has an influence on health through the reduction of air, water and soil pollution and the resulting decreased morbidity and mortality (Holland, 2008).

3.1.2 Energy

One means of reaching European climate change policy goals is to reduce greenhouse gas emissions in the energy sector. The second part of the thesis concentrates on energy performance of hospitals which is why European energy policy will be analysed in detail here.

European energy policy aims at sustainability of energy supply, both in terms of security of supply and the impact of energy use on the environment. Therefore, it fosters the creation of a competitive internal market for energy, the promotion of renewable resource for energy, a decrease in the dependence on imported fossil fuels and increasing energy efficiency. (European Commission, 2008a) It is guided by the provisions in the Commission's *"Action plan for energy efficiency: Realising the potential"* which identifies 10 priority areas to improve energy efficiency in all energy sectors. They include appliance and equipment labelling, minimum energy performance standards, building performance requirements, efficient power generation and distribution, vehicle fuel efficiency, facilitating financing of energy efficiency investments, increasing energy efficiency in the new member states, using energy taxation coherently, raising awareness of the issue and fostering energy efficiency in built-up areas and worldwide. (European Commission, 2006)

Directive 2009/28/EC on the use of energy from renewable sources (2009) provides a target of a 20% share of energy from renewable resources for all member states. Moreover, the directive sets a minimum share of 10% of all transport being supplied by biofuels[1] and the establishment of national action plans for renewable resources. Member states are required to

[1] Biofuels are fuels used for transport that are produced out of biological material, such as plants and woods

implement measures to allow producers of electricity from renewable sources to guarantee the origin of this electricity.

Because of the directive hospitals will be able to choose energy producers with high shares of renewable resources through the implementation of guarantees of origin for energy from renewable sources. Depending on the nature of the national action plans, member states may explicitly provide emission reductions for the health care sector. The Directive on promotion of renewable resources has an impact on health by reducing the share of fossil sources for electricity production, which decreases greenhouse gas emissions and thereby improves air quality, reduces morbidity and mortality (Holland, 2008).

The substance of *Directive 2004/8/EC* (2004) on the promotion of cogeneration[2] outlines the potential benefits of an increased use of cogeneration, which are saving energy, reducing emissions, increasing the security of energy supply and avoiding network losses. Cogeneration is defined in the Directive as the simultaneous production of energy for heating and electrical or mechanical energy. The Directive urges member states to establish support schemes for producers of cogeneration.

The Directive's influence on hospital policy depends on its national implementation because the member states are flexible in the way they interpret the provision of support mechanisms. It will mean that hospitals are directly or indirectly supported when installing a cogeneration plant. Therefore it is possible for hospitals to benefit from the energy savings financially after a shorter period of time than without national support. Cogeneration thereby has an impact on health because cogeneration saves energy consumption including greenhouse gas emissions.

Directive 2002/91/EC on energy efficiency of buildings (2002) requests member states to implement legislation that supports the improvement of energy performance in the building sector. This includes the increased use of energy performance certificates especially for public buildings and the setting of national minimum energy efficiency requirements. The Directive allots for a leadership role of the public sector in terms of energy performance. Therefore, the energy performance of buildings over 1000m^2 which are occupied by public authorities need to be assessed and awarded an energy certificate which is to be displayed in a prominent

[2] Cogeneration, or Combined heat and power generation, is the production of both heat and electricity by a plant that can be fired with different resources.

place. In case of the construction, sale or rental of any building, an energy certificate is also mandatory. In addition to the provision of energy certificates, for new buildings over 1000m^2, the application of alternative energy supply systems, such as renewable energy sources or combined heat and power (CHP) systems, needs to be taken into consideration.

After revision of the current Directive, the Commission has made a proposal for a revised Directive on buildings' energy performance. This proposal strengthens the role of energy certificates by extending their scope to public buildings of more than 250m^2, and it also widens the application of minimum energy efficiency requirements to these buildings when these are undergoing major renovation. (European Commission, 2008b) This reduction of the threshold causes the need for a lot of financial and human resources which are difficult to raise in the short time period allowed by the directive.

The impact of this Directive on hospitals depends on the national healthcare system and its implementation in the member states. Private hospitals do not fall under the scope of public buildings defined in the Directive, and therefore do not need energy certificates or comply with national minimum energy efficiency requirements. These provisions do apply to public hospitals and increase the need for monetary and human resources to maintain the standards. In addition to those differences, the implementation of the Directive varies in member states, according to the definition of low carbon buildings and the requirements to be fulfilled in order to be issued an energy efficiency certificate.

The health impacts of Directive 2002/91/EC vary in type. On the one hand, the improvement of energy efficiency of a hospital to meet national minimum energy efficiency requirements reduces its energy consumption, decreases greenhouse gas emissions and thereby increases public health. On the other hand, if the hospital has to spend financial and human resources on the assessment of its energy performance to get an energy certificate, it means that this money is not available for health care utilisation. And there is not a large health gain from an energy certificate because it only means assessment of the status and not an improvement in energy performance.

The eco-design of energy using products is guided by *Directive 2005/32/EC* which pursues the goal of reducing the adverse environmental impact of products throughout their life-cycle. It applies to all products that use energy, regardless of the energy source, except for vehicles.

The directive does not set out environmental requirements for specific products, but defines environmental aspects to be assessed for the fulfilment of requirements which will be established by measures to follow. (European Commission Directorate General Energy and Transport, 2009) Due to the ability to predict and plan most of the environmental impact of a product at the design stage, the environmental assessment should start during this phase. The aspects to be considered in an assessment are the consumption of materials, energy and other resources, emissions, pollution, generation of waste and possibilities for reuse, recycling or recovery of energy and materials. (Directive 2005/32/EC, 2005)

The impact on hospital policy of the eco-design directive cannot be extracted from the directive itself, but depends to a large extend on its implementation in the member states and on the follow-up legislation which will define specific product groups and requirements. Its impact on health, in either way will be positive because of stricter rules for the environmental impact of products and resulting reductions in emissions.

The European Commission Regulation implementing *Directive 2005/32/EC* of the European Parliament and of the Council with regard to eco-design requirements for fluorescent lamps without integrated ballast, for high intensity discharge lamps, and for ballasts and luminaries able to operate such lamps establishes minimum energy requirements for light bulbs and practically means a ban of incandescent light bulbs from 2012 in the EU. Special purpose lamps are excluded from the regulation. (Commission Regulation (EC) No. 245/2009, 2009) This regulation therefore has an influence on hospitals because hospitals will have to change their lighting equipment and use energy-saving light bulbs, but only in their offices. Health is influenced by the regulation because it leads to a decreased energy consumption and decreased use of mercury in fluorescent lamps and thus decreases air pollution.

The aim of enhancing the cost-effective improvement of energy end-use efficiency in the EU is pursued with *Directive 2006/32/EC* on energy end-use efficiency and energy services (2006) by setting targets, providing mechanisms, incentives and institutional, financial and legal frameworks. This directive indicates a national target of energy efficiency improvement of 9% within nine years, which is however not legally binding for member states. Member states are, on the other hand, required to set up national action plans to increase energy efficiency, which must lead to the public sector fulfilling an exemplary role.

Directive 2006/32/EC will have differing impacts on hospitals in the member states, depending on the form of implementation and the organisation of the health care sector. As in the case of the Energy efficiency of buildings Directive, this directive sets out a leading role of the public sector which means that the directive will have a larger impact on public hospitals than on private ones. In addition, the energy efficiency improvement programmes can differ in member states, and can include behavioural, technological and economic changes. (Directive 2006/32/EC, 2006) The effect on public health will nevertheless be positive, only with differences in its dimensions according to the implementation of member states.

Council Directive 2003/96/EC (2003) restructures the Community framework for the taxation of energy products and electricity by laying down Community minimum levels of taxation for most energy products. This means that most energy products will be more expensive after implementation of the directive. Certain products are exempted from the provisions of this document, such as fuels used for commercially used airplanes. In addition, member states are granted the freedom to apply differential tax rates based on several reasons of which one is that the fuel or energy source is used for public transport, waste collection, public administration, disabled people or ambulances. In addition, member states may reduce or exempt from the taxation energy which has been produced from renewable resources, natural gas and CHP generation.

The impact of Directive 2003/96/EC on hospitals is that hospitals' use of energy will get more expensive, which includes the use of heating and electricity. Since ambulance fuels can be taxed differently by member states, it depends on the individual implementation by member states how high the taxes for that fuel are and thereby how much hospital costs rise. Due to the increased costs for hospitals' energy consumption, the indirect effects of the directive on health are negative because the hospital will have to pay more for its energy consumption and thereby have less money to invest in health care. Only if the hospital uses renewable resources, natural gas or CHP for the generation of its energy, may it be exempted from higher taxation in member states and thereby save money on energy bills. Through the promotion of renewable energy and energy-efficient CHP generation, the directive promotes public health. Also the increased taxation for energy products is promoting health, except for the before explained special case of hospitals, because it will lead to a reduced consumption

of energy, followed by decreased greenhouse gas emissions and increased air quality (Holland, 2008).

3.2 Nature and biodiversity

Human action has caused a strongly accelerated speed of a loss of biodiversity in the past century. This loss of biodiversity has been acknowledged by the international community through the adoption of the *international Convention on Biological Diversity* of 1992. This convention defines biodiversity as "the variability among living organisms from all sources" (United Nations, 1993, p. 146) and aims primarily at conserving biodiversity, using its components sustainably, and sharing the benefits of the utilisation of genetic resources fairly. (United Nations, 1993) The EU has adopted the convention in 1993, and issued its own *biodiversity strategy* in 1998. The four priority themes, which include the first two of the United Nation's convention, and research, monitoring and exchange of information as well as educating and raising awareness, are the basis for the development of action plans that set out specific goals for the prevention of biodiversity loss. (European Commission, 1998)

Next to the Community biodiversity strategy, the EU has also adopted a directive to protect biodiversity in its territories. *Council Directive 92/43/EEC* on the conservation of natural habitats and of wild fauna and flora (1992) aims at conserving natural habitats in order to protect biodiversity. It defines habitat and species types of Community interest and priority habitats and species, which deserve special protection. Included in these habitats are alpine regions and the Mediterranean. Habitats of Community interest are in danger of disappearing or have a small natural range.

The impact on health of Directive 92/43/EEC is difficult to identify from its provisions. In the long run, a balanced eco-system with high biodiversity provides the best possible environment for humans to live in, but a direct positive impact on health cannot be recognised. The impact on hospitals is that if a hospital is built near a protected area as defined in the directive, national law has to be implemented to protect this area and that can have an influence on the planning of the hospital and its supplies.

3.3 Environment and health and quality of life

European action on environment and health is guided by four documents: The London declaration on health and the environment, the Budapest declaration on health and the

environment, the European environment and health strategy and the European environment and health action plan 2004-2010. None of these measures constitutes binding legislation, but they identify key areas of action and responses to those.

The first of these documents has been created at the ministerial conference on environment and health of the representatives from member states of the WHO European region in *London in 1999*. It declares the ministers' commitment to "action in partnership for improving the environment and health in the twenty-first century" (WHO Europe, 1999, p. 3) and sets out qualitative goals to achieve this commitment in different areas, such as water, transport and environment in relation to health and the implementation of national environment and health action plans. The follow-up conference on environment and health in *Budapest* has been concluded with a declaration, too, which emphasises the need to research and tackle children's environmental health and to improve environmental health in the new member states to reduce inequalities (WHO Europe, 2004).

The *European environment and health strategy* (European Commission, 2003) aims at a reduction in the disease burden attributable to environmental factors by identifying and preventing these factors and by strengthening EU capacities for policy-making in the field of environmental health. The strategy is built on the SCALE elements: being based on Science, focusing on Children, raising Awareness, using Legal instruments, including constant and continuous Evaluation. The implementation of the strategy is done incrementally, thus small steps are taken over a long period of time. The first cycle of this incremental strategy is to build up an integrated monitoring and response system for European environment and health.

Building on the provisions of the environment and health strategy, the Commission has issued the *European environment and health action plan 2004-2010*. This action plan constitutes the first cycle of implementation of the environment and health strategy, aiming at improving knowledge about the links between pollution and health effects by strengthening research and at a review of policies. Inclusion of all relevant stakeholders in the implementation of the plan is crucial for its success. (European Commission, 2004)

3.4 Natural resources and wastes

The *"Thematic strategy on the sustainable use of natural resources"* of the European Commission (2005) contributes to the reviewed sustainable development strategy by

addressing the need to prevent environmental degradation through sustainable use of natural resources. The approach to reaching that goal is to investigate and identify the negative impact of the use of materials and energy on the environment, which has to be done with a "cradle-to-grave approach", meaning that the impact is assessed throughout the whole life-cycle of a product. Based on the impact assessment, it will be the strategy's aim to decouple environmental impacts from economic growth, meaning to reduce environmental consequences despite a continuous economic growth. The Commission proposes to use non-legislative measures to reach the strategy's objectives, which include national programmes. These national programmes will be assessed by the Commission in order to identify those which can be applied at Community level, aiming at the integration of environmental concerns into all Community policies.

The European Commission's (2006a) communication on a *"Thematic programme for environment and sustainable management of natural resources including energy"* highlights the fact that environmental problems must be tackled globally in order to ensure sustainable access to natural resources for all. Special attention should be paid to the economic growth of developing countries, which should not entail an equal growth in resource use. The thematic programme led to the preparation of the "Thematic strategy for the environment and sustainable management of natural resources, including energy, which identifies five priority areas for action and proposes measures how to implement the priorities. The priorities are to assist developing countries in the integration of environmental sustainability in their decisions, to promote implementation of European environment initiatives and agreements, to integrate environment in EU policies and enhance their coherence, to strengthen international governance for environment and to support policy developments for sustainable energy technologies in third countries. (European Commission, 2007)

European waste policy is very comprehensive and provides legislation for different kinds of waste and treatment stages. Due to the limited room and relevance for the current research, the EU waste policy analysis will be restricted to the framework directive on waste, the directive on hazardous waste, which directly addresses medical waste, and the waste electrical and electronic equipment.

Directive 2008/98/EC on waste (2006) aims at the protection of human health and the environment by setting out provisions that restrict the production of waste and encourage the

recovery of waste and the use of this material. In addition, the collection, transport and storage of waste should be handled in a way that is least harmful to human and environmental health. In order to reach these objectives, member states are to implement national waste management plans and increase cooperation with each other. Qualitative and quantitative goals and indicators are introduced for member states to aim for. As for hazardous waste, member states have to guarantee the traceability of such waste, and have to sanction the mix of different kinds of hazadous waste or with non-hazardous waste.

The impact on health of this directive becomes clear in the provision that "Member States shall take the necessary measures to ensure that waste management is carried out without endangering human health" (Directive 2008/98/EC, 2008, p. L 312/14). The reduction of waste production and an increase of waste reuse increase health indirectly by reducing the amount of waste that needs to be transported to landfills or incinerated, which saves energy. In addition, a less harmful collection and transportation will mean that environmentally friendly cars with fewer emissions will be used, leading to decreased pollution and the positive consequences to health as outlined in Holland (2008).

Hospitals are directly affected by the hazardous waste directive and the Commission decision because Annex III to Directive 2008/98/EC (2008) lists waste that is considered hazardous which includes many types of waste that can be found in hospitals, such as infectious, carcinogenic or toxic compounds. Therefore, hospitals have to dispose of their hazardous waste in accordance with the directive's provisions. The impact of the directive on human health can be identified in the greater safety of hazardous waste disposal if its provisions are applied. This is due to the ability to trace back hazardous waste to its source and to the prevention of a mixture of different kinds of wastes which reduces the danger of an accidental normal disposal of hazardous waste and the possibility of production and emission of new dangerous substances from the mixed compounds.

Directive 2002/96/EC governs the management of waste from electrical and electronic equipment (WEEE). It aims at the prevention of this type of waste and, where this is not possible, at reducing its disposal by increasing reuse, recycling or recovery. The objective is that in each member state, the rate of collection of WEEE from private households reaches an amount of four kilograms per person. (Directive 2002/96/EC, 2003) This objective has been proposed to be changed to amount to 65% of waste per member state to take into account that

in some member states there is a larger amount of WEEE than in others (European Commission, 2008c). The means to establish higher WEEE collection rates is to guarantee to private households the possibility to return electrical and electronic equipment free of charge to special collection facilities. The collection and treatment of WEEE from consumers who are not private households has to be financed by producers for products that have been sold after 13 August 2005. For products sold before this date, producers may be allowed by member states to charge consumers for waste treatment and collection. (Directive 2002/96/EC, 2003)

Hospitals are affected by Directive 2002/96/EC through the provisions made for the collection of waste from consumers other than private households. In case equipment needs to be disposed of that has been bought before August 2005, the hospital may, depending on implementation in the member state, be charged a fee for the environmentally sound treatment of that waste (Directive 2002/96/EC, 2003). The directive has a positive influence on health because it decreases the amount of WEEE that goes to landfill and increases the amount that is reused or recycled. This means that fewer substances that might be found in WEEE can pollute air, soil and ground water at a landfill, and that resources are saved by reusing resources from old electrical and electronic equipment. An indirect negative influence on health could be induced by the possibility of member states to induce the costs for WEEE treatment and collection on consumers who are not private households, who include hospitals. This money spent on waste treatment can not be spent on the treatment of patients.

3.5 Certification schemes

The EU has established several voluntary certification schemes which are awarded for good environmental performance. The first one is the *EN ISO 14001 norm*, which is the European implementation of the international ISO 14001. It has been implemented by Commission Regulation (EC) No. 196/2006 (2006), which also takes account of the revision of the norm in 2004. The ISO 14001 norm sets requirements for a voluntarily established environmental management system, and has been operational since 1996 (The ISO14000 Environmental Management Group, 2002). To comply with the norm, organisations or companies must set up an environmental management system and commit to comply with legal provisions and to improve the environmental management system periodically. The compliance with

requirements is regularly checked by objective auditors. (Commission Regulation (EC) No. 196/2006, 2006)

The *Eco-Management and Audit Scheme* (EMAS) is another voluntary European environmental certificate. It is governed by Regulation (EC) No. 761/2001 (2001) and built upon the provisions of ISO 14001. Therefore, an organisation which is already certified by ISO 14001 only has to take some additional steps to be awarded the EMAS label. The requirements for the award of EMAS are stricter than for 14001, insofar as for EMAS, a company has to improve environmental performance annually, is required to have environmental performance audits done by accredited environmental verifiers and also has to report regularly to the public about their performance. (European Commission, 2008)

The influence of the ISO and EMAS schemes on hospitals are several fold. On the one hand, the environmental management system saves money. On the other hand, with increased communication due to the environmental management scheme, overall hospital management can improve and in addition, the hospital's reputation increases in a population which cares about environmental issues. (Health Care Without Harm, 2006) An environmental management scheme influences health if it leads to reduced energy consumption or emissions. Due to the fact that it is a management system, this impact often depends on its cost-effectiveness.

A third environmental certification in the EU is the *Eco-label*, governed by Regulation 1980/2000. This voluntary scheme is limited to certain products and therefore affects hospitals only indirectly. The eco-label can be awarded to all products, except food, feed, medical devices and medicinal products. It is based on a life cycle analysis of the environmental impact of a product. Hospitals cannot themselves apply for the EU eco-label, but they can buy products that have been awarded the label. (European Commission Directorate General Environment, 2008)

The influence on health is based on the environmental improvement of the producer, who will reduce emissions related to production, chemical use and/or use of resources. Thereby, air quality and worker safety will be improved which has an impact on public health.

Chapter 4 – Good practices

This part of the thesis will give an overview of the results of the survey which has been conducted among European hospitals. The survey, conducted through the dissemination of a questionnaire and additional telephone interviews has resulted in the identification of 25 hospitals (see Annex C for complete list of hospitals) that have improved their energy performance either by increasing energy efficiency or by changing to renewable resources and are therefore considered as good practices. An example will be described in this section for the different actions that have been identified, namely improving building efficiency, installation of energy-saving equipment, training of staff, training of patients, installation of a CHP plant, transport, use of geothermal energy, biomass, solar power, wind and hydropower.

4.1 Improved building efficiency

For this section, two examples will be presented because of the large difference of possible actions in an existing building and a newly built hospital. The example of an existing building will be Nicosia General Hospital in Cyprus and the new hospital presented is Hospital de Mollet in Spain.

The general hospital of Nicosia, Cyprus has opened in 2006 with a building that was not planned according to the goal of high energy efficiency. A new management has lead to recruiting an energy auditor to propose measures to reduce the hospital's energy demand. The difficulty for actions to be taken is that most of the departments in the hospital have already taken up their work. (P. Yiavris, personal communication, May 18, 2009) At the moment, measures to reduce energy consumption are taken mostly in the still unoccupied departments and in the ones that are not used during weekends. The first step to increase the building insulation will be to apply a special membrane to the windows to enhance their insulation characteristics. (P. Yiavris, personal communication, April 23, 2009)

In addition to actions on the building itself, the hospital's equipment is energy-efficient and, especially the lights and air conditioners are being used increasingly only during times of demand and need. The hospital is investigating the feasibility of a solar installation. (P. Yiavris, personal communication, May 18, 2009)

The Spanish Hospital de Mollet in Mollet del Vallès is an example of a newly built facility with a high standard of energy efficiency. The advantage of a new building for energy demand reduction is that all aspects of the building can be modified to meet high energy efficiency standards. In this way, the design of hospital de Mollet could take into account the building's orientation to optimise sun radiation, its shape and the use of light colours to guarantee a high utilisation of daylight, a ventilated façade and improved insulation of windows, walls and roofs and the protection of glass windows against radiation. (Castella, 2007)

In addition to the high energy efficiency of its buildings, hospital de Mollet has installed equipment with a low energy consumption which is regulated by an automatic building management system, geothermal storage for half of the heating and cooling demand and photovoltaic units with a peak capacity of 84 kWh. (F.G. Charlez, personal communication, May 18, 2009)

4.2 Installation of energy-saving equipment

The Krankenhaus der Elisabethinen in Linz, Austria is an example of a hospital which has been able to reduce its energy consumption by 10% through the energy-optimisation of equipment. The reason for this action was a major renovation of the over 20-year-old hospital buildings, necessary to update the facilities to the needs of modern health care. (K. Schrögendorfer, personal communication, May 7, 2009) The main measures taken were related to the use of heating and air conditioning facilities. The installation of more efficient motors for ventilation systems and pumps was one of the activities. The introduction of free cooling[3] and heat recovery in air conditioners enabled the more efficient use of these. (K. Schrögendorfer, personal communication, April 20, 2009) The heat recovery of air from air conditioners makes it possible to use the warm exhaust air from the rooms to pre-heat the cold outside air so that the heat energy demand is reduced. The cooling system has also been refurbished to save energy. An installation has been installed which uses ground water to cool the ceilings in the rooms. For this purpose, a well was dug from which ground water is extracted, runs along the hospital ceiling and is fed back into another well. Therefore, no water is lost in the process but only the energy from the ground water is used for cooling. (K. Schrögendorfer, personal communication, May 7, 2009)

[3] Free cooling in air conditioners means that when the outside air is cooler than the inside, the air conditioner uses the outside air to cool the inside without utilising the refrigeration mechanism

In addition to the explained technical improvements of facilities the Elisabethinen hospital has implemented a demand-driven use of ventilation systems. The facilities are regulated by a building automation system which controls heating and cooling through outside temperatures and puts air conditioners on night mode, reducing air volumes both in office areas and also in patient rooms. The Elisabethinen hospital takes efforts to train their staff to reduce their energy consumption and to improve the energy efficiency of their buildings, and will take steps in the near future, to equip the new facilities as energy-saving as possible whenever there is a renovation. (K. Schrögendorfer, personal communication, May 7, 2009)

4.3 Training of staff

The Virga Jesseziekenhuis in Hasselt, Belgium has among other activities put a large effort in saving energy by making their employees aware of energy costs. The participation in the six sigma project and the energy audit that has to be completed for this participation have shown that changing employees' behaviour offers a large energy-saving potential. (K. Strijkers, personal communication, April 23, 2009) During the energy audit, it became clear that a change in energy consumption of the hospital staff could save a large amount of energy because their use of facilities such as light and computers was not energy-efficient. Facilities were left on at night and even during vacations, which is why an energy-month was initiated at Virga Jesse hospital to raise the awareness of the price of energy and thereby reduce consumption. The energy-month consisted of games and competitions, where staff could win prices for cutting back on energy consumption or had a good idea how to make savings. In addition to these activities, participating employees were given advice and brochures how to decrease their energy consumption at home. This measure not only increased the interest in the project but also helped to accomplish the desired change in behaviour which is a difficult task. The hospital staff has established a committee which meets with the hospital direction once a month to discuss possibilities how to decrease energy consumption. Another energy-month is planned, too in order to keep the awareness of energy costs and consumption changes high. (K. Strijkers, personal communication, May 13, 2009)

Next to the activities which raise employees' awareness the hospital has invested in energy-saving equipment and motion detectors for light installations and has been equipped with a CHP plant that produces part of electricity and the energy demand for heating and hot water. For the future, there are plans to install solar panels during the next major renovation and

other possibilities to use renewable resources are investigated. (K. Strijkers, personal communication, May 13, 2009)

4.4 Training of patients

Helsingborgs Lasarett in Helsingborg, Sweden is engaging in energy-saving by training staff and patients how to reduce their energy consumption. An information campaign with posters, highlighting ways to save energy by using facilities such as light and computers responsibly, has cut the hospital's energy bill by 15%. This large amount of energy savings is due to high commitment among staff and patients. (P. Jansson, personal communication, May 18, 2009)

Besides training people, Helsingborg hospital has saved energy by increasing the energy efficiency of their buildings and changing equipment to more energy-efficient alternatives. These actions have been financed through energy performance contracting, with the contractor financing the measures and guaranteeing certain energy savings, and additionally a campaign of the Swedish government granted 30% of the investments back to the hospital. This grant has been invested again in energy-saving activities. The hospital's environmental management system has been certified according to the ISO 14001 norm and has the approval to be granted the Swedish ss 627750 label, which attests a well-functioning management and increase of the energy-efficiency. (P. Jansson, personal communication, May 18, 2009)

4.5 Installation of a combined heat and power plant

Brežice hospital in Slovenia has installed a CHP plant on-site and through this and other energy-saving measures has saved 31% of their energy consumption since the beginning of these activities. The CHP plant at the hospital consists of two boilers with a capacity of 1020 kW each, which means that it is capable of producing the hospital's total energy demand for heating and hot water. The resource used to fire this plant is gas, which is different from the situation before the reconstruction where oil was used to produce heating energy. (R. Skvarč, personal communication, April 7, 2009) In the new installation, oil is only used as an emergency fuel. The lower-emission alternative gas was chosen over other options, such as solar energy, biomass and oil, because of its economic effectiveness and the safety of supply. (R. Skvarč, personal communication, May 13, 2009) To guarantee smooth operation of the new technology and increase energy savings the hospital staff was and is provided training about the handling of the technology and the correct way of heating and ventilating rooms.

Additional steps taken to save energy were to refurbish the hospital kitchen with energy-efficient extractors instead of steam boilers for steam production, installing automatic regulation of the heating system through the use of outside temperature sensors and thermostat valves with thermostat heads to reduce unnecessary heating. (R. Skvarč, personal communication, April 7, 2009)

Brežice hospital has decided to engage a contractor who financed 80% of the investment needed for the infrastructure construction and manages and maintains the facilities for 15 years. This investment is paid back by the hospital through the energy savings reached through the contractors investments, and after the contract is completed the hospital can benefit from all the savings made. (R. Skvarč, personal communication, May 13, 2009)

4.6 Energy-saving transport

The sygehus Sønderjylland is an example of a hospital which has increased the energy efficiency of its staff's transport to work by taking part in a community-wide initiative to increase the use of bicycles.

About half of the hospital staff is participating in the initiative which encourages the use of bikes for the travel from and to work in the community of Sønderborg. The means to animate people to bike to work instead of using their car is to do it through a competition, where participants can win prices for large distances travelled by bike. In this way, people use less cars to go to work and thus save greenhouse gas emissions. (P. Ertzinger, personal communication, May 29, 2009)

In addition to the biking initiative, the hospital Sønderjylland has installed energy-saving equipment and increased the energy efficiency of their buildings after an energy audit has identified possibilities to do so. Through that, 13% of the hospital's energy consumption could be avoided, (P. Ertzinger, personal communication, April 23, 2009) which does not only save energy costs but also earns additional money due to an agreement with the Danish government which gives the hospital a singular payment for every kWh of energy saved. In addition to this agreement, the Danish law provides for a 4% reduction of energy consumption within the next two years. This goal will be reached by increasing the energy efficiency of buildings and appliances further. (P. Ertzinger, personal communication, May 29, 2009)

The hospital Sønderjylland is participating in the green network Sønderjylland, which is a voluntary cooperation between institutions and companies in this region with the aim of improving environmental and work-environmental aspects (CSR Vaderegio, n.d.), and has been awarded the "EMO", a Danish energy label. This label certifies a reduced energy consumption of all buildings and installations through an energy audit (P. Ertzinger, personal communication, May 29, 2009).

4.7 Geothermal energy

Deventer Ziekenhuis in Deventer, the Netherlands is an example of a good practice for their use of geothermal heat and cold storage[4] to provide energy. The old hospital was outdated and thus a new hospital has been built in 2008 with measures to reduce its energy consumption and environmental impact. The heat and cold storage installation at the newly built hospital is based on four wells, which were necessary because the level of ground water at the hospital's location is too high to bore only two, deeper wells. In these wells, seasonal storage of heat and cold takes place in a layer of sand, which keeps the temperature at 7°C in the cold sources and at around 15°C in the heat sources. (Boonstra, 2005) It is not possible to measure the exact capacities of the storage system yet, but it is expected that it will provide all the cooling energy needed and 80% of the heating demand. The heating demand is covered by a combination of pre-heating through the heat wells and an energy-efficient heat pump which provides the missing heat to the air. Only during peak-load times, the heating has to be supplemented by gas-fired boilers. In addition to the heating of air, a gas-fired CHP installation supplies the energy needed for hot water demands. (P. Middelkamp, personal communication, May 5, 2009)

In addition to the geothermal storage, the new Deventer Ziekenhuis uses an all-air system which provides ventilation with outside air and recovers excess heat produced by the air conditioning by storing it in the wells. Energy consumption is reduced by a high level of insulation of the building, the coverage of large parts of the roof with sedum flowers and high utilisation of sunlight in patient rooms. The total of actions taken lead to a projected energy

[4] Geothermal energy is energy derived from the naturally occurring different, but constant temperatures at varying levels of depth in the ground, in this case directly used for heating and cooling purposes

saving of 31% and CO_2 saving of 25% compared to the situation in the old hospital. (Boonstra, 2005)

Deventer Ziekenhuis is part of the project "HOSPITALS – Exemplar energy conscious European hospitals and health care buildings" which has provided part of the costs for energy-saving measures and offers a platform for the exchange of good practices. For the future, the hospital staff plans to save more energy by optimizing the use of heating and ventilation, with demand-driven performance. (P. Middelkamp, personal communication, May 5, 2009)

4.8 Biomass

An example of a hospital that uses biomass for a large part of its energy need is the Luisenklinik Bad Dürrheim in Germany. The psychiatric hospital with 60 beds has achieved a reduction of their CO_2 emissions by 40.5% and decreased energy consumption by 20.5%. The use of renewable resources in the hospital is dominated by the use of a biomass-fired CHP plant which has a capacity of 1090 MWh per year and thereby produces 70% of the heating demand, equivalent to 50% of the total energy needed. The biomass used for this installation is wood pellets[5]. The second renewable resource used at the Luisenklinik is solar energy through photovoltaic units on the roofs of several buildings. (A. Dickhoff, personal communication, April 23, 2009)

The Luisenklinik has already in the early 1990s started to consider environmental aspects during renovations, and within this course switched from oil to gas, leading to a reduction in emissions. Additional measures which increased the energy efficiency of the hospital were the installation of windows with high insulation characteristics, increasing the insulation of the hospital's buildings including the roofs and the purchase of energy-efficient equipment for the kitchen. Demand-driven utilisation of heating and ventilation systems and the provision of information about energy-saving behaviour to both staff and patients maximize energy-savings with existing equipment. (BUND Berlin, 2009)

[5] Wood pellets are highly pressed wood waste with low moisture content, leading to minimal CO_2 emission during the burning process (Mahapatra, Gustavsson & Madlener, 2007)

4.9 Solar power

The installation of a photovoltaic unit with the capacity of 50 kW at peak demand on the roof of the Centre hospitalier Emile Mayrisch in Esch, Luxembourg in cooperation with the Centre Henri Tudor to realize a research project is an example of a good practice of solar energy utilisation. The amount of electricity generated by the photovoltaic unit is, in comparison to the hospital's electricity demand, only a small fraction of under 1%, but constitutes an interesting example due to its research component. (M. Klesen, personal communication, May 15, 2009) The Centre de Recherche Public Henri Tudor (*Public Research Centre Henri Tudor*) is measuring in real time what the efficiency of the unit is based on the sun intake and electricity production and can, through the installation of a reference test field test the efficiency of newly marketed solar modules in comparison to the existing unit. This research project made rendered it possible for the hospital to receive 57% of the investment from the European Regional Development Fund. The photovoltaic panel does not cause maintenance costs to the hospital because of the guarantee of over 20 years which the manufacturing company provides. (M. Klesen, personal communication, May 18, 2009)

The centre hospitalier Emile Mayrisch improves its energy performance through the utilisation of a CHP plant which produces heat and more than enough electricity for the hospital's demand. The electricity is, due to existing legislation, fed into the local electricity grid. The energy consumption is reduced by increasing the building insulation and basing energy use on the actual demand, for example through sensors in the windows which automatically turn off heating and cooling when the windows are opened. An energy monitoring system will help in the future to identify possibilities to save more energy. Future measures that are planned are the improvement of the insulation of the oldest building's roof and the installation of a larger photovoltaic unit on that same roof, as well as the utilisation of rain water for irrigation of green areas and cooling purposes in air conditioners. (M. Klesen, personal communication, May 18, 2009)

In 2008, the Centre hospitalier Emile Mayrisch has received the solarprice from the Luxembourgish section of "Eurosolar" and has been awarded the "Q-Excellence"-label by the European Foundation for Quality Management, which certifies high-level quality management and includes energy and environment in its audits. (M. Klesen, personal communication, May 18, 2009)

4.10 Wind

As an example of a hospital that utilizes wind power for energy production, Antrim Area hospital in Northern Ireland will be presented in this section. On the grounds of this hospital, a wind turbine generates 1,200,000 kWh of electricity per year which saves the hospital 90,000£ on electricity costs. (Sustainable development commission, 2006) The turbine was installed at the beginning of 2005 and the initial concerns that the noise would disturb hospital patients and employees were not confirmed. The wind generator was installed in a size that produced the optimal amount of energy to supply the hospital, which was for the hospital trust the more cost-effective option compared to building a larger turbine that could export energy. (P. Henderson, personal communication, May 11, 2009) In this way, the whole electricity needed during the night and two thirds of the electricity demand during the day can be covered by wind energy. The funding of the project, which was a difficulty in the beginning was covered to 80% by the United Kingdom (UK) Energy Efficiency Fund, which is granted for energy efficiency projects in the public sector. (Sustainable development commission, 2006) In addition to this fund, the hospital can take part in the Renewable Obligation Certificates (ROCs) scheme, which is applicable to the UK. ROCs are certificates that prove the production of a certain amount of energy from renewable resources and can be sold to energy suppliers who do not reach the prescribed share of renewable resources in their production (OFGEM, 2007).

In addition to the wind power generation, Antrim United Hospitals Trust has installed CHP plants and a biomass boiler, upgraded their lighting installations, created staff awareness boards and train newly incoming staff on energy-saving behaviour. (P. Henderson, personal communication, May 11, 2009)

4.11 Hydropower

This research has not identified a European hospital which produces energy through the use of hydropower, therefore the Portuguese hospital Fernando da Fonseca will be presented in this section due to their purchase of electricity from a provider who guarantees a 12% share of hydropower in the electricity production. This guarantee is provided for by Directive 2001/77/EC on the promotion of renewable resources for electricity production.

In addition to the purchase of electricity produced partly from hydropower and from solar power, hospital Fernando da Fonseca has reduced its energy demand through the introduction of a technical management system that automatically reduces the light and air conditioning consumption of non-essential areas during low-demand hours. The lighting system in the hospital has been upgraded to the use of electronic ballasts for fluorescent lamps instead of the more energy-consuming magnetic ballasts. (J.P. Ferreira, personal communication, April 8, 2009)

Chapter 5 - Discussion and Conclusion

This chapter discusses the results and the design of this study, gives recommendations for the future and a final conclusion.

5.1 Answering research questions

This study has shown that EU environment policy is very comprehensive. It is guided by the 6th EAP of the European Commission, which identifies priority areas of environmental action in the EU. Although not a legally binding document, the EAP has initiated the adoption of several legal texts. The priority areas in the EAP are climate change, environment and health and quality of life, natural biodiversity, and natural resources and waste. The environment policy is not fully covered by this categorisation, but due to time and space limitations, this thesis cannot analyse environment policy further.

The impact of environment policy on hospitals often depends on national implementation of EU law, since most legislation on environment is made up of directives which give member states the possibility to adapt the legislation to their national settings. An impact on health thereby often also depends on national adaptations, but clearly it is mostly positive because of reductions in greenhouse gas emissions. Only the quantity of reductions depends on member states. The positive impact on health of enivronment policy is anchored in the Treaty of the European Union, stating that environment policy needs to protect human health in Article 174, and that public health concerns need to be incorporated in all policies (Article 152).

Good practices of hospitals that have improved energy performance can be found all over Europe. They consitute examples of hospitals that are proactive in the implementation of energy policies by exceeding their aims. The activities that hospitals iniate to reduce energy consumption include the improvement of their buildings' energy consumption, the installation of CHP plants for simultaneous production of heat and electricity, exchange of equipment with energy-saving alternatives and its demand-oriented utilisation, encouragement of energy-saving transport, and training of patients and workers how to save energy. Examples of hospitals which use renewable energy sources could be identified for biomass, solar, wind and geothermal energy. The use of hydropower is limited to a hospital which buys electricity from a provider who guarantees the utilisation of hydropower for production.

The hospitals' context is important for the existence and kind of good practices to be found. Not only do geographical differences influence the hospitals' choice how to improve energy consumption, also and foremost the financial aids available at a local, national or European level and the laws in the countries influence a hospital's decision whether and how to change energy use. Financial constraints are named as the main difficulty in implementing energy measures by the hospitals. Their motivation results mostly from the possibility of saving energy expenses and from their consciousness of having the social responsibility to improve energy consumption.

5.2 Advantages and limitations of study design

The study design of reputational case sampling had the advantage of giving access to a large number of hospitals through member organisations of HOPE. In addition, the representatives of these organisations all speak English, which reduces the language barrier to reach hospitals in many countries. A limitation of this approach was that some of the organisations' representatives sent the questionnaire directly to hospitals without informing the researcher how many hospitals have been contacted. Thus, the researcher did not know the exact number of hospitals contacted and could not estimate how many answers to expect. This had a negative impact on time planning because more unexpected questionnaires were returned after the process of choosing the examples to present had already started. A further limitation is that some hospitals which had been selected to be presented did not respond to emails and phone calls. Thereby possible additional information was lost.

The analysis of the impact on hospitals by environment policy was limited by time, space and language constraints because often national implementation heavily influences this impact, and this could not be included in the analysis. The relation between EU environment policy and hospitals was only analysed in a general way, and not based on the actual hospitals included in the study. Therefore, the items in the questionnaire asking about hospitals' motivation to engage in environmental improvements could not be analysed in depth, but only in a descriptive manner. The results of the survey among hospitals did show, however, that European laws are implemented in hospitals, for instance the renewable energy directive which made it possible for the hospital Fernando da Fonsica to get a guarantee of origin for their electricity, or hospital de Mollet in Spain which is built according to the highest

European building requirements. But because of a lack of national analysis of the EU laws, this relationship cannot be scientifically proven.

5.3 Recommendations

Based on this study, it is recommended to researchers to initiate in-depth analysis of the reasons why hospitals decide to improve their environmental performance in order to be able to give advice to policy-makers and hospital managers how to improve the conditions to do so.

For the future of the topic of good practices in hospitals' environmental performance, the researcher recommends to increase presentation and dissemination of good practices all over Europe to help raise awareness among hospitals which are the ways to reduce their environmental impact. In addition, an exchange of practices can increase knowledge about the legal and financial constraints and possibilities with regard to environmental action.

5.4 Conclusion

Environmental concerns affect hospitals in times of growing air pollution and global warming. Their mandate to ensure the health of people includes the responsibility to reduce the negative impact on health through environmental pollution as much as possible. In Europe, there are examples of hospitals who are proactive in their efforts to improve their energy performance, reduce greenhouse gas emissions, and thus improve environmental health. These examples need to be highlighted in order to raise awareness about the topic among hospitals and the population so that the good examples are taken up by others.

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Annex A - Questionnaire

Green hospitals

This questionnaire is part of a HOPE project, which tries to identify good practices among hospitals in the field of energy use.
Environment and health are strongly linked. Therefore, hospitals can influence the health of citizens not only through the provision of healthcare, but also through the nature and size of its environmental impact.

HOPE (The European Hospital and Healthcare Federation) is a non-governmental organisation which has the mission of improving the health of the European citizens. This mission is achieved by the dissemination of information to hospitals and policy-makers, by maintaining links with European health providers and by establishing and strengthening exchange between them.
HOPE Board of Governors has decided that HOPE shall investigate the influence of EU environment policy on hospitals. This project is part of this mandate.

We kindly ask you to fill in this questionnaire, which is made up of 5 worksheets covering the following topics: general information about the hospital and its environmental activities; information about possible energy efficiency improvement measures, as well as renewable resource use; the hospital's motivation to engage in environmental action and expectations toward the future; and sources of funding for the projects.

The questionnaire will be analysed at HOPE and 5 to 8 cases will be selected for further investigation. The selected hospitals will be approached for a telephone interview to gather further information about the previously named topics. These cases will be presented in a paper, which will synthesize this information with an overview of EU environmental policy.

Please return the completed questionnaire until April 30th.

By **email**: green@hope.be

Questionnaire green hospitals

General information

1) The hospital

Name of the hospital: _____
Website: _____
Name of Contact person: _____
Email address: _____
Phone number: _____

1a	Number of beds	click here to choose size	possible answers: < 250 beds 250 - 500 beds 500 - 1000 beds > 1000 beds

1b	What types of activities are provided in the hospital?	secondary care	yes or no
		tertiary care	yes or no
		long-term care	yes or no

1c	What is the hospital's ownership?	click here to choose ownership	possible answers: public private not for profit private for profit

1d What is the hospital's energy demand? ___ kWh

1e What are the hospital's total greenhouse gas emissions? ___ tonnes CO2 equivalent

2) Resources

2a What resource(s) do you use or procure for energy production?

coal	yes or no	makes up __% of energy demand
oil	yes or no	makes up __% of energy demand
nuclear	yes or no	makes up __% of energy demand
natural gas	yes or no	makes up __% of energy demand
geothermal	yes or no	makes up __% of energy demand
biomass	yes or no	makes up __% of energy demand
solar	yes or no	makes up __% of energy demand
hydropower	yes or no	makes up __% of energy demand
wind	yes or no	makes up __% of energy demand

3) Environmental action

3a What action(s) have you taken?

Improving energy efficiency	yes or no	if yes, please click here to continue
Using renewable resources	yes or no	if yes, please click here to continue

Questionnaire green hospitals

Energy efficiency improvement

4) Action to improve energy efficiency

4a Can you please name certification schemes you are using or have applied for?
(for example EMAS, ISO 14001, national label schemes)
Were you awarded the label? Why or why not?

4b How did you improve energy efficiency?

Installation of energy-saving electric equipment	yes or no
Combined heat and power generation	yes or no
Improving energy efficiency of the building(s)	yes or no
Training of staff	yes or no
Training of patients	yes or no
Change of car fleet	yes or no
Other, please specify:	

4c When did you start to improve energy efficiency?

Installation of energy-saving electric equipment	click to choose	possible answers for all items:
Combined heat and power generation	click to choose	change of legislation
Improving energy efficiency of the building(s)	click to choose	construction of hospita
Training of staff	click to choose	major renovation
Training of patients	click to choose	new management
Change of car fleet	click to choose	no specific occasion
Other, please specify:		

4d Could you please shortly describe the action(s) taken?
(Actors involved, start of implementation etc.)

5) Results of energy efficiency improvement

5a How much did the energy consumption decrease?

_____ kWh
_____ % of total consumption

other unit of measurement, please specify: _____

5b How much did the greenhouse gas emissions decrease?

_____ tonnes
_____ % of total emission

If you also use renewables, please click here to continue
If you do not use renewables, please click here to continue

Questionnaire green hospitals

Use of renewables

6) Resource use

6a Can you please name certification schemes you are using or have applied for?
(for example EMAS, ISO 14001, national label schemes)
Were you awarded the label? Why or why not?

6b What is the major renewable resource you use? click here to choose

possible answers:
geothermal
biomass
solar
hydropower
wind

6c When did you start using renewable resources? click here to choose

possible answers:
change of legislation
construction of hospital
major renovation
new management
no specific occasion

6d Could you please shortly describe the actions taken to increase use of renewable resources?
(actors involved, start of implementation etc.)

7) Results of renewable energy use

7a How much of your energy demand can you produce on-site?

_____ kWh
_____ % of total energy demand

7b Is there an energy surplus that can be sold? yes or no

7c How much did the greenhouse gas emissions decrease?

_____ tonnes
_____ % of total emissions

Please click here to continue

Questionnaire green hospitals

Motivation and expectations

8) Motivation

8a What are the two main reasons for the hospital to engage in environmental improvement?

It is the law	click to choose	*m*	possible answers for all items:
It will be the law in the future	click to choose	*a*	yes
It is a social responsibility	click to choose	*x*	no answer
It is an investment in the future	click to choose	*i*	
It will save the hospital money	click to choose	*m*	
It gives us good publicity	click to choose	*u*	
It increases public health	click to choose	*m*	
Other, please specify:	_____	*2*	

9) **Difficulties**

9a Can you please describe difficulties you have encountered in the implementation of your actions?

10) Expectations

10a In your opinion, how will national requirements of environmental performance develop in the future?

click to choose	possible answers: requirements will increase requirements will stay the same requirements will decrease I do not know

10b In your opinion, will the development of national legislation regarding the requirements of environmental performance be imposed by European legislation?

click to choose	possible answers: yes no

Please click here to continue

Questionnaire green hospitals

Funding

11) Sources of funding

11a What were funding sources that were used to improve environmental performance?

Hospital budget	yes or no	made up ___% of total cost
European Union	yes or no	made up ___% of total cost
* European Structural Fund	yes or no	
* LIFE+	yes or no	
* Other, please specify:	_____	
National funding	yes or no	made up ___% of total cost
* Name(s)	_____	
Local or regional funding	yes or no	made up ___% of total cost
Private funding	yes or no	made up ___% of total cost
Other, please specify: _____		made up ___% of total cost

12) Size of investment

12a How long will / did it take for the hospital to depreciate its investment?

click to choose	possible answers:
	no investment by hospital
	< 5 years
	5 - 10 years
	10 - 15 years
	15 - 20 years
	> 20 years

End of questionnaire

Annex B – Interview

Introduction	• Introduction of researcher • Purpose of the study • Use of data for Bachelor thesis • Admission to tape-record interview • Storage of data
Topical questions (semi-structured questions)	• Depending on the details already given in the questionnaire or through documents, not all of the topics were addressed in every interview: o The measures taken at the hospital to save energy o The reasons why the hospital has started to engage in energy-saving behaviour o How much energy and emissions are saved per year due to the changes in behaviour o The sources of funding and difficulties experienced in the hospital's actions o Whether the hospital is planning to increase energy savings in the future
Finalisation	• Admission to contact person again in case of further questions, if not already given
Storage of data	• Digital storage of tape-recorded interview • Storage of typed-out interview
Duration	• Between 8 and 40 minutes, depending on information needed

Annex C – Complete list of hospitals

Country	Hospital	Energy efficiency improvement	Renewable resources used
Austria	Allgemeines Krankenhaus Wien – University hospital	• Energy-saving equipment • Building insulation • Training of staff	• District heating and cooling
	Landeskrankenhaus Freistadt	• Energy-saving equipment • Building insulation	• Biomass
	Krankenhaus der Elisabethinen Linz	• Energy-saving equipment • Building insulation • Training of staff	
Belgium	Virga Jesseziekenhuis Hasselt	• Energy-saving equipment • CHP • Training of staff	
Cyprus	Nicosia General hospital	• Energy-saving equipment • Building insulation • Training of staff	
Denmark	Amager hospital	• Energy-saving equipment • Building insulation • Training of staff	
	Bornholms hospital	• Energy-saving equipment • CHP • Building insulation	• Electricity partly from hydropower
	Hilleroed hospital	• Energy-saving equipment • Training of staff	
	Sygehus Sønderjylland	• Energy-saving equipment • Building insulation • Training of staff	• Electricity partly from o Solar o Hydropower o Wind
Germany	Luisenklinik Bad Dürrheim	• Energy-saving equipment • CHP • Building insulation • Training of staff • Training of patients	• Biomass • Solar
	LWL Klinik Lippstadt	• Energy-saving equipment • CHP • Building insulation • Training of staff	
Luxembourg	Hôpital Kirchberg	• Energy-saving equipment • Building insulation	• Electricity partly from o Solar o Hydropower o Biomass
	Centre Hospitalier Emile Mayrisch	• Equipment • CHP • Building • Staff training	• Solar
Netherlands	Deventer Ziekenhuis	• Energy-saving equipment • CHP • Building insulation	

Portugal	Maternidade Dr. Alfredo da Costa	• Energy-saving equipment • Building insulation • Training of staff	
	Hospital Amato Lusitano		• Hydropower
	Hospital Santa Maria		• Solar
	Unidade Local de Saúde Norte Alentejano	• Energy-saving equipment • Building insulation • Change of car fleet	• Hydropower • Solar
	Hospital Fernando da Fonseca	• Energy-saving equipment • Building insulation • Training of staff	• Elecricity partly from o Hydropower o Wind
	Centro Hospitalar Psiquiátrico de Lisboa	• Energy-saving equipment	• Solar
	Centro Hospitalar do Alto Ave EPE (CHAA)	• Energy-saving equipment • CHP • Building insulation • Training of staff • Training of patients • Change of car fleet	• Solar
	Centro Hospitalar Vila Nova de Gaia/Espinho	• Energy-saving equipment • Building insulation	
Slovenia	Brezice Hospital	• Energy-saving equipment • CHP • Building insulation • Training of staff	
Spain	Hospital de Mollet	• Building energy efficiency • Energy-saving equipment	• Geothermal • Solar
Sweden	Helsingborgs Lasarett	• Energy-saving equipment • Building insulation • Training of staff • Training of patients	• Biomass • Solar • Excess heat
United Kingdom	Antrim Area hospital	• CHP • Energy-saving equipment • Staff training	• Wind energy • Biomass