Streamer
European research on energy-efficient healthcare districts

D7.9

State-of-the-art of energy-efficient healthcare districts

Deliverable Report D7.9- FINAL

Streamer - Optimised design methodologies for energy-efficient buildings integrated in the neighbourhood energy systems.
The Streamer project is co-financed by the European Commission under the seventh research framework programme FP7.EeB.NMP.2013-5 ; GA No. 608739)

D7.9

State-of-the-art of energy-efficient healthcare districts: Report of desk and field surveys that are necessary to provide input to taxonomy development and typology modelling in WP1 as well as state-of-the-art review on EeB technologies in WP2.

Issue Date March 2015

Produced by Commissariat A L'Energie Atomique Et Aux Energies Alternatives (CEA)

Main author Hassan A. Sleiman (CEA), Sylvain Robert (CEA)

Co-authors Martin Aizlewood (TRF), John Cartwright (TRF), Peter Jolley (TRF), Andrea Giuntini (AOUC), Beatrice Turillazzi (AOUC), Luca Marzi (AOUC), Ernesto Iadanza (AOUC), Sergio Leone (AOUC), Giacomo Bizzarri, Omar Ambrogi(BEQ) , Roberto Di Giulio(IAA), Costanza Quentin (IAA), Anna Rokicka (MOW), Piotr Dymarski (MOW), Elsa Fahlen(NCC), Mikael Nutsos (LOC), Thierry Juif (BOU), Didier bourdon (APH), El hadi Benmansour (APH), Kevin Violant (APH), Stefan van Nederpelt (DJG), Oana Schippers-Trifan (DMO), Freek Bomhof (TNO), Roberto Taversari (TNO), Marc Koster (RNS)

Version FINAL

Dissemination PU

Document history

Version	Date	Status	Produced by	Comments
1.0	2015/01/31	Final draft	Hassan A. Sleiman	Last version before review process
2.6	2015/02/26	Accepted	Marc Bourdeau (TC)	Acceptance of revised version after review process
		Approved	Freek Bomhof (PC)	

Colophon

The STREAMER project is co-financed by the European Commission under the seventh research framework programme with contract No.: 608739 - FP7-2013-NMP-ENV-EeB. The information in this publication does not necessarily represent the view of the European Commission. The European Commission shall not in any way be liable or responsible for the use of any such knowledge, information or data, or of the consequences thereof.

Publishable executive summary

Hospitals consume large amounts of energy, with continuous need for heating and air conditioning to keep patients comfortable, good lighting for staff to work in, significant amounts of electronic medical equipment and lots of laundry to be done. Energy prices and the Carbon Reduction Commitment (CRC) mean that high energy use results in high bills, and pollution. Reducing energy use and utilising renewable sources of energy can free up money to be spent on front-line patient services and to reduce the environmental impact of healthcare districts.

Local conditions may have an impact upon the choice of which technology is selected. For instance, it is of no practical use to install a wind turbine at a site where there is a dense population of trees or the building is located in a valley. Initiatives are underway to lessen the impact of building related carbon emissions. Several methods of achieving the carbon reduction via the decrease of electricity and gas consumption have been highlighted and these are relevant to STREAMER. Other measures such as installation of CHP are included but these are part of a larger scope of works directly related to building improvements.

This deliverable includes information related to energy efficiency improvements and practices presently being applied to hospitals in Europe countries, namely: UK, Italy, Poland, Sweden, Netherlands, and France. For each of the previous countries, a general description of the current practices for energy system solutions is provided and a study of the national hospitals that have made energy efficiency implementation is presented. The hospital projects and the current practices, studied in this document, provide an insight into the carbon-driven reduction targets set for healthcare centres and the options that have been considered along with various methods of procurement.

This deliverable studies the "State-of-the-art of energy-efficient healthcare districts", and is meant to summarize the outcomes of a desk survey about related National and European initiatives such as networks and projects. The document is structured into eleven sections and an introduction. The first six sections correspond to each one of the National clusters involved in STREAMER project, namely: UK, Italy, Poland, Sweden, Netherlands, and France, in which we survey a list of hospitals that have made energy efficient implementation, and the current practices and technologies used in hospitals for energy efficiency. Section 9 briefly surveys the European, National and Local Legislation Related to Energy Efficiency in Hospitals, whereas Section 10 lists the conferences and research projects in Europe related to energy efficient buildings. Section 11 surveys two international guidelines for energy efficient buildings, namely DIN 1945/87, and ASHRAE. Finally, we conclude our work in Section 12.

As a final conclusion, we can notice that the EU governments and citizens are aware of the importance of energy efficiency in buildings, especially in healthcare districts, and are heavily working on reducing energy consumptions by their policies, practices, and laws to help reduce the environmental impact of new and existing buildings.

Our conclusions are that although there are already many regulations in EU on energy efficiency in buildings, it is important to keep them updated by considering the latest technologies for this purpose and to support the initiatives who aim at zero energy buildings. Furthermore, the number of healthcare districts that have made energy efficiency implementation is still not that high if compared to the total number of healthcare districts in Europe, and finally, more research projects, guidelines, and dissemination shall be performed to report on the achieved results and to acknowledge about the future direction and practices to reduce the environmental impact. Finally, the reported cases, in which BIM technologies were used, prove that STREAMER's objectives can be achieved and that there is a large potential for energy savings by using already existing technologies.

List of acronyms and abbreviations

- BIM: Building Information Model
- BPIE: Building Performance Institute Europe
- CHP: Combined Heat & Power
- CRC: Carbon Reduction Commitment
- CSR: Corporate & Social Responsibility
- DNO: District Network Operator
- EeB: Energy efficient buildings
- EPCs: Energy Performance Contracts
- ESCO: Energy Service Companies
- GHG: Greenhouse Gases
- HAS: French Health Authority
- HVAC: Heating, Ventilation, and Air Conditioning
- IT: Information Technology
- KPIs: Key Performance Indicators
- MEP: Mechanical, Electrical, Plumbing
- NHS: National Health Service
- OWP Operational Work Plan
- PC: Project Coordinator
- PEP: Polish Energy Policy
- PSC Project Steering Committee
- PTC Project Technical Committee
- SALAR: Swedish Association of Local Authorities and Regions.
- STREAMER Semantics-driven Design through Geo and Building Information Modelling for Energy-efficient Buildings Integrated in Mixed-use Healthcare Districts
- TC Technical Coordinator
- WP Work Package
- WPL Work Package Leader

1. Table of Contents

2. Introduction

Healthcare districts and campus include buildings of different types, providing a range of different services, of which, many of them are operating 24 hours per day. The energy use of such healthcare districts could easily exceed that of 20,000 dwellings, especially when they count on new medical equipment. It is not surprising then, that Healthcare districts are on the top of EU priorities for energy efficiency, and that the healthcare districts themselves are seeking to substantially reduce their energy consumption.

Currently, energy efficiency in buildings, in many countries, falls under governmental regulations whose focus is to reduce building energy consumption. These standards may differ according to the regions or climatic conditions, and to the different types of buildings, such as residential or simple buildings, commercial buildings and more complicated high-rise buildings.

The aim of this deliverable is to describe and analyse current approaches to encourage energy efficiency in healthcare buildings, based on the analysis of the current regulations, practices, and vision. It studies the State-of-the-art of energy-efficient healthcare districts, and it is meant to summarise the outcomes of a desk survey about related National and European initiatives networks, projects, and conferences. Furthermore, it describes the healthcare centres that have implemented energy efficiency measures, and current technologies being installed and used to reduce energy consumption, without sacrificing their functions, neither the users comfort.

According to our study, some conclusions can be drawn: there is no doubt that healthcare centers are high energy consumers, which explains the previous, current, and future inversions in projects, regulations, and improvements to reduce the energy consumption and increase the efficiency in healthcare centers. This is why EU governments have approved long and short term goals to tackle the energy consumption problem. A high number of healthcare centres in Europe have already carried out some refurbishment or practices to reduce energy consumption, but this number is not high when compared to the total number of centres in Europe. It is true that approved regulations, codes, and legislations shall insure and increase energy efficiency in buildings, but they have to be accompanied by supporting zero-energy buildings and setting up initiative packages, for new and existing buildings, to address the barriers in implementing energy efficiency in them.

Further than the previous conclusions, the study of the state of the art in several European countries has shown that there is a large potential for energy savings by using already existing technologies, by optimising the operation of ventilation systems already installed and by utilising local energy sources. In addition, the good energy efficiency already achieved among some of the studied hospitals is an example on how BIM and ICT software provided by STREAMER shall help reducing the energy consumption at healthcare centres by 50%.

As for STREAMER, one of its objectives is to fill the gap between the existing and future legislations and regulations by providing design assessment tools that could help the involved actors to easily evaluate the energy related features while designing and monitoring them. Furthermore, after analysing the current state of the art in European practices at healthcare centres, and after analysing STREAMER's demonstration sites, it is time to show that there is a large energy saving potential in the demonstration projects, and that STREAMER results shall help identify the improvements and practices that shall be carried out to achieve the 50% energy reduction in healthcare centres during the next years.

This document is structured in ten sections and an introduction and a conclusion sections. The first six sections correspond to each one of the National clusters involved in STREAMER project, namely: UK, Italy, Poland, Sweden, Netherlands, and France, in which we survey a list of hospitals that have made energy efficient implementation, and the current practices and technologies used in hospitals for energy efficiency. Section 9 briefly surveys the European, National and Local Legislation Related to Energy Efficiency in Hospitals, whereas Section 10 lists the conferences and research projects in Europe related to energy efficient buildings. Section 11 surveys two international guidelines for energy efficient buildings, namely DIN 1945/87, and ASHRAE. Finally, we conclude our work in Section 12.

3. UK section

3.1 Introduction

3.1.1 Background

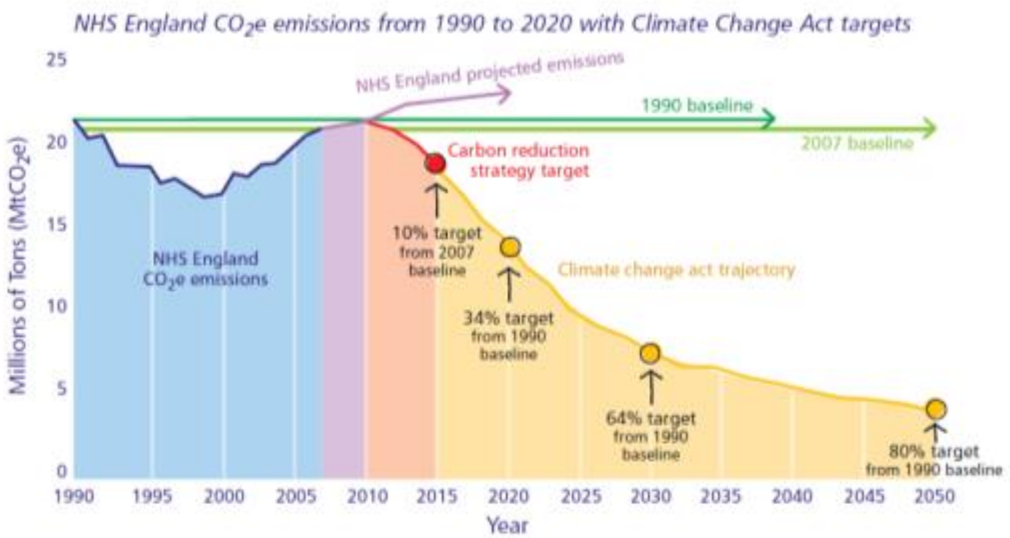
SAVING CARBON – SAVING LIVES

Climate Change is one of the greatest threats to our health and well-being. It is likely to have significant impact for health in the UK. The NHS has a significant role to play in reducing carbon emissions supporting the UK to adapt to Climate Change.

A sustainable future for the NHS community will be one that embraces collaboration and innovation and identifies means of driving the highest quality clinical care through environmental improvements. Action is being taken throughout the NHS to reduce its impact upon the environment. Combined Heat and Power systems, efficient boilers, energy efficient lighting, renewable energy generation, upgraded heating controls and building thermal improvements such as improved insulation and better protection from the sun are examples of such initiatives now being implemented.

The UK government has committed to take action now by the Climate Change Act 2008, which sets binding targets to cut carbon emissions. As the largest public sector contributor to carbon emissions the NHS has committed to achieve the following carbon reduction targets based upon 1990 figures:

- 10% by 2015
- 34% by 2020
- 80% by 2050



Successful delivery of this sustainability strategy depends upon effective measurement against national and international targets. Key areas of measurement and comparison include:

- The CRC Energy Efficiency Scheme (CRC)
- European Union Energy Trading Scheme (EUETS)
- Estates Return Information Collection (ERIC)

- BREEAM for Healthcare Assessment Model
- Display Energy Certificate (DEC)
- Energy Performance Certificate (EPC)

3.1.2 Aim

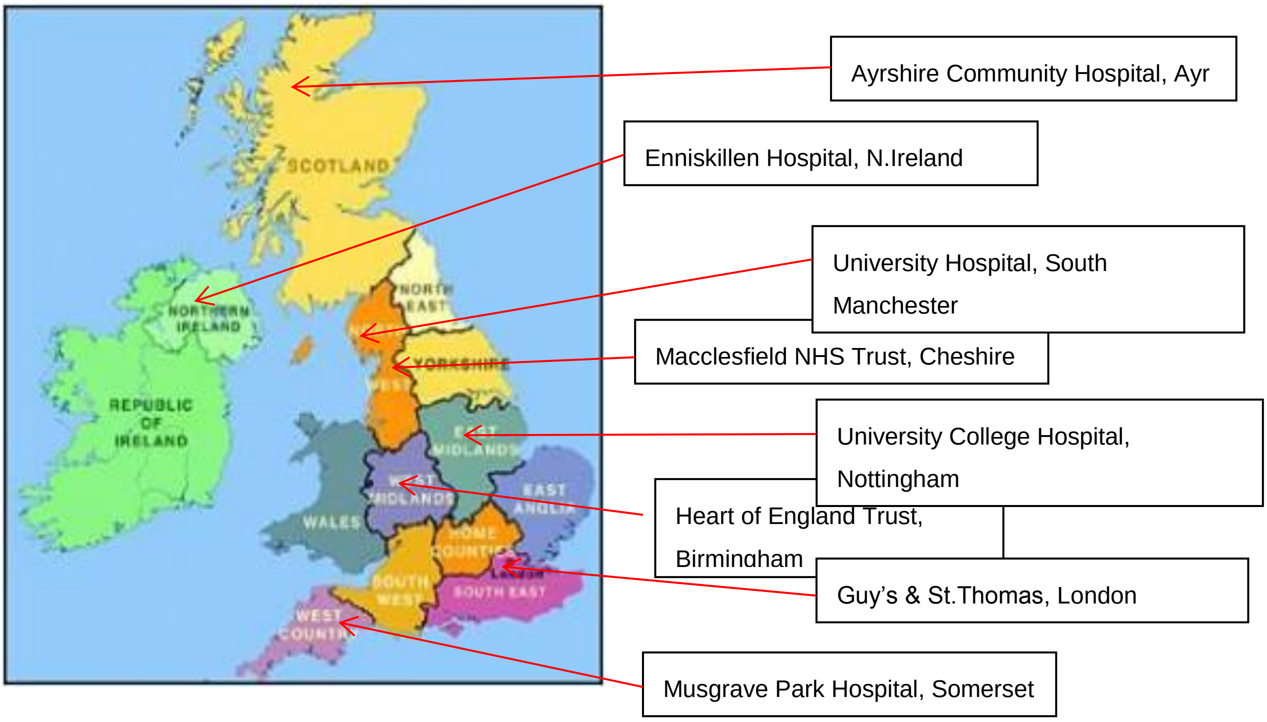
The aim of this work is to provide an overview of several UK hospital projects (either recently completed or in progress) that have identified energy efficiency measures and renewable energy technologies. Examples of these energy efficiency measures are listed. It is intended that the experience and knowledge gained from these UK hospital projects could be applied in implementation of similar energy solutions in other EU countries.

3.1.3 Method

The purpose of this document is to share knowledge and experience from energy system solutions at hospital areas in the UK. This is done by describing the energy system solutions for a number of UK hospitals.

3.1.4 Scope and limitations

To provide an overview of the UK a sample of hospitals from England, Scotland and Northern Ireland have been selected.



The hospitals / Foundation Trusts that have been chosen are:

- Ayrshire Community Hospital / Girvan Community Hospital, Scotland
- Enniskillen Hospital, Northern Ireland
- University Hospital South Manchester (UHSM)
- Macclesfield General Hospital / Congleton War Memorial Hospital
- University College Hospital Nottingham (UCHN)
- Heartlands Hospital, Heart of England Foundation Trust (HEFT) Birmingham

- Guy's & St. Thomas' Foundation Trust
- Musgrave Park Hospital, Taunton

3.2 The List of UK Hospitals that have implemented energy efficient measures

Below are listed 8 UK hospitals. Each has identified its own measures to achieve the necessary energy and carbon reduction targets. Various methods have been used to procure these means including self-finance, low interest loans, Energy Performance Contracts (EPCs) with third parties and shared savings schemes. The differing ways of overcoming the unique challenges for each individual hospital provide a broad spectrum of solutions. Each method has merits but it is up to each individual Trust to apply whichever method works best for them within their financial limitations.

3.2.1 Ayrshire (Crosshouse) Community Hospital / Girvan Community Hospital, Scotland

TITLE	Ayrshire Community Hospital
Reference	www.greenenergy.net
Status	Publicly available
Language	English
Outline	For the last year an NHS Community Hospital in Ayr has been benefitting from having a 40m wind turbine in their car park. Installed at Girvan Community Hospital the 100kW wind turbine has generated an impressive 18% more power than predicted
Relevance	Other green energy measures taken by the hospital include a 700kW biomass heating system, a rainwater harvesting system and low energy lighting.
Summary	Prior to installation it was estimated that the turbine could provide 25% of the electricity demand on site, offset 122 tonnes of carbon pa and realize £50k annually in Feed-In tariffs. Payback would be around 6 years. The wind turbine has produced 226,000 kWh in an average wind speed of just 5.6 m/s over the course of the past year and this has resulted in considerable savings for the hospital in reduced energy bills and income generation from the FITs. The turbine sits at the edge of the car park and is very quiet even in high wind speeds due to the small blades.
Relationship to STREAMER	Energy Efficient Buildings (EeB) is an important feature contained within the STREAMER agenda and a renewable source such as a wind turbine sits well within this category
WP7 partner	TRF/ARU

Ayrshire NHS Trust has chosen to install a 700 kW biomass heating system at Ayrshire Community Hospital in order to reduce energy and lower carbon emissions. The burning of pellets in the biomass boiler has generated over 5.2 million kWh of emission free heat, and 70% of hot water and heating load to the site at the peak winter period and 100% during the summer. A 40 metre, 100kW wind turbine will be installed at Girvan Community Hospital at a cost of £1.3m. It will save approximately £300,000 per year which means it would pay for itself in just over 4 years. The Trust has also undertaken to install LED lighting in place of the existing out of date fluorescent lighting at Crosshouse Hospital in the following areas: Main stairwells; lift lobbies and circulation areas outside wards; main dining room; car park lighting. Within the circulation areas and stairwells, as well as installing LED lighting, presence detection has been incorporated. This has allowed the lighting to be dimmed down to 10% of the full load when the areas are unoccupied. Carbon emissions have fallen by 11.45% and electricity consumption by 5.44%. Whilst these figures are not wholly attributable to the LED lighting, it undoubtedly played a major part in the reductions.

Biomass Boiler

Wind Turbine

LED Lighting

3.2.2 Enniskillen Hospital, N. Ireland

TITLE	Enniskillen Hospital
Reference	www.maplesunscreening.co.uk
Status	Publicly available
Language	English
Outline	A stylish, external solar shading is providing effective control of solar gain, light and glare at a new hospital in Enniskillen, Northern Ireland.
Relevance	Solar shading, brise soleil and climate façade are all possible building related interventions that could be adopted as part of the Energy Efficient Buildings (EeB) segment of STREAMER
Summary	The brise soleil and screen package compliments the extensive use of wood and glass in the hospital's façade. Natural wood panels shade the south facing elevation, while specially angled glass louvres protect the hospital's clinical facilities from direct sunlight. The solar shading system will begin to pay for itself from day one with energy savings for the hospital; it will cut its

	carbon footprint by reducing cooling and heating requirements. Solar shading to the south facing façade of the hospital is provided by an all timber system featuring a distinctive aerofoil blade design. Panels measuring 280 x 44mm were manufactured in natural pine to compliment the building's exterior cladding. A glass louvre shading system is installed to exterior glazing in the hospital's clinical laboratories to control light intake. Specially designed for the application, the 700 x 200mm louvres are fabricated from toughened laminated glass with a frosted finish. Installing the louvres at a 30^0 angle, with each glass fin overlapping by about 100mm ensures that only northern light can enter and so protects the interior from the potentially damaging effects of solar radiation from intense southern light
Relationship to STREAMER	The solar shading work will overlap Project STREAMER in respect of lessening the cooling / heating requirements of the building
Additional comments	
WP7 partner	TRF/ARU

Enniskillen Hospital in Northern Ireland has embarked upon an external solution that will provide a resolution to solar gain, glare and ingress of natural daylight. Solar shading, brise soleil and an external climate façade have been adopted to provide the reductions at the hospital.

Winner of the Building Design Class 2013 of the Building Better Healthcare awards, the judges' comments were as follows:

- *"The design provides a benchmark for future hospitals"*
- *"It is a very fine building and a concept that we feel is moving the argument forward. It is a genuine piece of innovation"*
- *"This project raises the bar and shows what can be done. It is an exceptional scheme"*

A complete brise soleil and screen package has been designed which compliments the extensive use of wood and glass in the hospital's landmark façade. Natural wood panels featuring a distinctive aerofoil blade design shade the south facing elevation, while specially angled glass louvre shades protect the hospital's clinical facilities from direct sunlight.

Specially designed for the application, the glass louvre shades for the clinical areas were fabricated from toughened laminated glass with a frosted finish. Installed at a 30 degree angle, each glass fin overlaps by about 100mm, ensuring that only Northern light can enter and so protecting the interior from the potentially damaging effects of solar radiation from intense Southern light.

Completing the product package is a bespoke mesh screen with a copper-look finish which provides a dramatic architectural statement at the main entrance. Built at a cost of £200m, David Ortiz, Design Manager for the main contractor said *"The solar shading system will begin to pay for itself from day one with energy savings for the hospital. It will cut the carbon footprint by reducing cooling and heating requirements"*

3.2.3 University Hospital South Manchester (UHSM)

TITLE	University Hospital of South Manchester (UHSM)
Reference	*www.uhms.nhs.uk*
Status	Publicly available
Language	English
Outline	UHSM website details the energy saving / carbon reducing that have been identified and will be implemented in the near future.
Relevance	UHSM is already a leading energy-efficient light in the movement to improve the UK's hospital environmental performance, installing measures including biomass boilers, ground source heat pumps, energy efficient lighting, and insulation and advanced building controls.
Summary	UHSM is considering voltage stabilization units that will regulate power to various parts of the hospital, reducing energy consumption by 8%, energy meters that will allow high consumption areas to be identified and software that will turn off IT equipment when it has not been used for a predetermined time. Success is measured in both pounds and tonnes of carbon saved. Indeed, since the advent of the governments Carbon Reduction Commitment (CRC) Energy Efficiency Scheme where organisations pay a £12 per tonne levy for every tonne of carbon emitted, they equate to the same thing.

Relationship to STREAMER	Whilst Project STREAMER deals primarily with the modelling of building based interventions, much of what UHSM is looking at is very relevant in terms of State of the Art buildings and improvements to the building envelope.
Additional comments	
WP7 partner	TRF/ARU

University Hospital of South Manchester has maintained its title “Britain’s Greenest Hospital” for the third year running thanks to a growing carbon efficiency programme and the determination of staff to save energy and “think green”.

UHSM have identified and implemented several energy saving / carbon reducing schemes including the installation of heat exchangers, biomass boilers, ground source heat pumps, energy efficient lighting, pipe insulation and advanced building controls. UHSM will also look to install a sophisticated software solution that will put all PCs to sleep after a predetermined time in idle mode. These initiatives have resulted in an overall energy reduction of 28% since the introduction of Carbon Management 5 years ago. UHSM has more plans to improve energy efficiency on site including Voltage Optimisation and further lighting and window upgrades.



The image on the left shows an underground heating coil for a Ground Source Heat Pump (GSHP). The centre image shows insulation added to a large heating main and on the right hand side is a smart heating controller.

The recent addition of the biomass boilers will reduce CO_2 emissions by a further 3,459 tonnes and will be equivalent to the emissions associated with 494 domestic properties. Two 2MW biomass boilers (shown below) are fed from a walking-floor container of woodchips, with a buffer to allow continuous operation whilst the container is being changed. The container is parked on a weighbridge which automatically sends back data to the fuel supplier so that they know when a new container is required. In addition to the main biomass boilers a smaller 200 kW biomass boiler and a 50 kW GSHP have been installed in buildings that are not connected to the steam distribution system.

Information on carbon and energy savings is as follows:

- Improvements to insulation, glazing and the heating systems and associated controls have resulted in 27% cut in overall demand for heating
- Electricity use cut by 6% through upgrades to ventilation motors and lights, new lighting controls and behavioural change in the staff
- Gas use cut by 47% as a result of the efficiency work and the installation of over 4 MW of biomass heating capacity
- Overall use of non-renewable energy cut by 36%
- The energy savings and the shift from gas and oil to wood fuel have resulted in a drop of 5,000 tonnes (28%) in annual CO_2 emissions over the 5 years to 2013
- Financial savings of around £390,000 pa at current energy prices

3.2.4 Macclesfield General Hospital (MGH)/ Congleton War Memorial Hospital (CWMH)

TITLE	East Cheshire NHS Trust (Macclesfield General Hospital & Congleton War Memorial Hospital)
Reference	Macclesfield Express (local newspaper) and www.eastcheshire.nhs.uk
Status	Publicly available
Language	English
Outline	The Macclesfield Express, a local newspaper, has run an article publicising the innovations to be implemented at Macclesfield General Hospital (MGH) and Congleton War Memorial Hospital (CWMH) and a page has been dedicated to this story on the Trust's website.
Relevance	East Cheshire NHS Trust (MGH & CWMH) has started work on a major energy saving scheme which will in June 2014 which will reduce its environmental impact and electricity bills at the same time.

Summary	The project will shrink the Trust's carbon footprint by around 30%, the equivalent to more than 2,000 tonnes of carbon each year. The centerpiece of the scheme will be a 530 electrical kilowatt (kWe) Combined Heat & Power (CHP) generator system, which will be installed at MGH. The CHP will use gas to create a large proportion of the hospital's electricity and use the heat produced in the process to warm the hospital through its central heating system. Other energy efficiency improvements across both MGH and CWMH will include the replacement of 3,250 light fittings with high efficiency LED lighting, together with additional boiler efficiency improvements. The energy improvements are projected to deliver carbon dioxide emissions savings of 2,049 tonnes per year
Relationship to STREAMER	Retrofitting of old buildings with the installation of insulation to valves and pipes and upgrades to pumps and chiller units mirrors some of the interventions planned within the STREAMER project. Improvements to the Building Energy Management System also falls within the STREAMER remit for Energy Efficient Buildings (EeB)
Additional comments	Although a major part of the energy savings will come via the CHP there are a great deal of savings to be made from the building improvements highlighted in Project STREAMER
WP7 partner	TRF/ARU

East Cheshire NHS Trust has started work on a major energy saving scheme which will reduce environmental impact and electricity bills. The project will shrink its carbon footprint by around 30%, the equivalent of more than 2,000 tonnes of carbon each year, and by significantly reducing the amount of electricity that the Trust buys from the grid, it will also save around £2.5m over the next 15 years.
The centrepiece of the scheme will be a 530 kWe CHP generator system, which will be installed in an existing plant room at Macclesfield General Hospital (MGH). The CHP will use gas to create a large proportion of the hospital's electricity – and use the heat produced in the process to warm the hospital through its central heating system.

Along with the installation of the CHP generator, inefficient electric radiators pumps and ageing electric air chillers at MGH will be replaced with modern, energy efficient alternatives. The scheme will also involve the insulation of valves and pipes, and fine tuning of the Building Energy Management System (BMS).
Other energy improvements across both MGH and CWMH will include the replacement of 3,250 light fittings with high efficiency LED lighting, together with additional boiler efficiency improvements such as new burners being fitted to the boilers and boiler controls being upgraded. A State of the Art boiler house, costing in the region of £350,000 has cut energy bills by 20% at MGH.

The first image shows a CHP engine, the second image shows an LED panel and the far right image shows new boiler burners.

The energy improvements are projected to deliver carbon dioxide emissions savings of 2.049 tonnes per year – equivalent to the environmental benefit of removing 683 family sized cars from the road or planting 1,680 acres of forest.

3.2.5 University College Hospital Nottingham (UCHN)

TITLE	*Nottingham University Hospital*
Reference	www.nuh.nhs.uk
Status	Publicly available
Language	English
Outline	Nottingham University Hospital (NUH) has announced a 15 year plan to upgrade and manage the Queen's Medical Centre's (QMC) on-site power plant, as well as introduce an energy efficiency programme that will reduce energy use and save approximately £2.8m.
Relevance	NUH is incorporating State of the Art LED lighting and heating controls to its estate, and so is very relevant to Project STREAMER.
Summary	The project will partner E.ON utility group with the hospital's support services and construction partner Interserve, to upgrade the QMC campus' CHP plant as well as install energy saving measures including boiler optimisation technology, low energy LED lighting and Building Energy Management controls. It is expected that measures will deliver carbon reductions of 16,000 tonnes and cost savings of £2.8m pa. The upgraded equipment, combined with the new energy saving measures will also help QMC comply with the new EU environmental regulations regarding greenhouse gas (GHG) emissions.
Relationship to STREAMER	The work that NUH are embarking upon will overlap Project STREAMER in that lighting and controls will form a State of the Art solution to existing

	buildings
Additional comments	
WP7 partner	TRF/ARU

Nottingham University College Hospital has made the decision to work with partners and incorporate Energy Performance Contracts (EPC) into its energy strategy going forward. An EPC allows an organisation to improve the energy efficiency of its buildings without having to raise the upfront capital itself, instead paying back the initial investment through the cost savings guaranteed in the agreement. The main hospital site currently has a coal fired boiler heating system and through the Smart Energy City project the potential will be explored for a linked energy supply from Nottingham Energy Park to the hospital. The Energy Park is a proposed business park development on a 6.75 hectare site in the Northwest of the city, 4 miles from the hospital. The concept behind the Business Park is that as energy costs are an increasing concern, business will gain a competitive advantage by being able to access clean, secure and cheaper power, generated on site at the Energy Park.

A 15 year plan has been announced to upgrade and manage the Queen's Medical Centre on site generating plant. UCHN have committed to partnership working via an EPC. The existing CHP plant generates 4.9 MW of electricity from a single gas turbine and the waste heat recovery produces 12 tonnes of steam per hour. A three way partnership between UCHN, E.On (energy provider) and Interserve (Trust construction partner) has been agreed and the scheme is envisaged to deliver a saving of 16,000 tonnes of carbon. As well as upgrading and managing the on-site power plant, £7.5m is being invested to finance the installation of a suite of energy production and reduction measures, paid back in 15 years, including energy saving measures such as boiler optimisation technology, low energy LED lighting and building energy management controls, that will guarantee dramatic reductions in energy use and make guaranteed savings in the region of £2.8m per year over the 15 year lifetime of the project by reducing energy costs and carbon emissions. All the savings have been guaranteed by the energy supplier E.On. These measures are expected to deliver carbon reduction of 7,400 tonnes per year across the Trust, equivalent of taking 3,300 cars off the road.



The image above left depicts the partnership working to achieve the savings. An EPC, or something similar, is an option to implement large schemes for no upfront cost, with fees being taken out of a share of savings made or through Feed In Tariffs (FITs) etc. where applicable. The centre image shows the coal fired boilers and the right hand image shows State of the Art LED lighting, with subtle tones and mood lighting designed to create a better environment and also aid healing.

3.2.6 Heartland's Hospital, Heart of England Trust, Birmingham (HEFT)

TITLE	*Heart of England NHS Foundation Trust (HEFT)*
Reference	www.cew.coop solarpowerportal.co.uk
Status	Publicly available
Language	English
Outline	The Heart of England Foundation Trust (HEFT) has partnered with renewable installer, Ecolution, to install solar PV arrays at Solihull Hospital and Heartlands Hospital in Birmingham
Relevance	Many hospitals across the UK are realizing the potential of solar panels as a source of renewable energy. The Feed-In tariffs could generate millions of pounds for them. The energy produced by the sun is clean, free renewable energy and solar PV is a very attractive investment for a community building
Summary	Both hospitals are benefitting from the electricity generated from their 250 kWp of roof mounted arrays. HEFT identified solar as a means of saving energy, cutting costs and reducing the hospital's footprint. Ecolution chose black-framed Hyundai 250W modules, using over 2,000 panels across 28 roofs – all with varying pitch, orientation, height and covering. The installations were completed in less than 6 months. The arrays are predicted to deliver over £2m in associated savings and Feed-In tariff payments over the next 20 years. Before the installation of solar HEFT spent more than £1m pa on energy. The solar arrays are expected to save it over 10% on its current expenditure
Relationship to STREAMER	Solar PV is one of the most popular sources of renewable energy and as such will feature highly across the range of initiatives investigated during STREAMER
WP7 partner	TRF/ARU

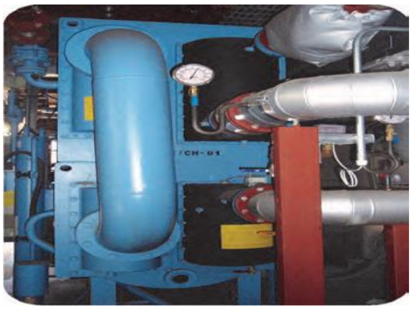
HEFT has partnered with renewables installer, Ecolution, to install solar PV arrays at Solihull and Heartlands Hospitals in Birmingham. A 250 kWp array has been installed and is expected to save the
Trust 10% of its electricity each year.

The image shows a roof mounted array similar to the installation at Heartlands.

Heartland's £5m Energy Centre is located at the hospital's main entrance and was developed with its energy solutions partner EnerG. The Centre is responsible for reducing the hospital's energy costs and providing savings of more than £688,000 per year.

The Energy Centre's State of the Art system, which has replaced ageing coal fired boilers and consists of a 1165 kW CHP, steam raising boilers and is connected to a 300 kW absorption cooling system, also helps to improve the hospital's carbon footprint in line with its pledge to reduce carbon emissions by 25% in 5 years. The absorption chiller produces chilled water from waste heat for warmer months. This means that the electrically powered chillers will run much less frequently during the summer and that spare cooling capacity can be used to provide air conditioning to areas of the hospital which had not previously benefitted from this. Heartland's CO_2 emissions have already been cut by more than 5,600 tonnes this year. In just one year this alone produced the equivalent environmental benefit of removing 1,555 cars from the road and 55,000 tonnes of carbon have been saved since the start of the project in 2008. The Energy Centre has reduced the hospital's energy consumption by 21%, CO_2 emissions by 42% and its energy spend by 24%.

There is also a similar absorption chiller and CHP at Heartland's sister hospital at Solihull (below) and this system



will generate annual cost savings of £293,000 and cut annual CO_2 emissions by 1,920 tonnes.

Work has also been carried out to upgrade lighting with 1.800 high efficiency and low energy fittings, which will further reduce emissions and energy costs. Other energy saving measures include automatic personal computer shutdown and computer controlled heating.

3.2.7 Guy's & St. Thomas' Trust (GAST)

TITLE	*Guy's & St. Thomas' Trust (GAST)*
Reference	www.gast.nhs.uk
Status	Publicly available
Language	English
Outline	A Combined Heat & Power (CHP) has been installed along with other energy saving innovations, both retrofitted and new
Relevance	Although the main focus of attention is on the CHP this is just one project in a whole raft of energy saving solutions all of which can be related to STREAMER
Summary	GAST is one of the busiest NHS Foundation Trusts in the UK, employing around 10,000 people and serving 850,000 patients every year. In the 3 years from 2010 GAST has realised a 20% year on year carbon reduction (double the NHS target for the period). As a result it has cut its energy bills by over £1.7m pa. key activities undertaken include the installation of the largest CHP capacity in the NHS, the addition of energy efficiency measures during refurbishment of Guy's Tower, updates to the hospital catering and laundry facilities, improvements to the heating and lighting controls and the extension of the hospital's Building Management System (BMS) to previously unconnected areas. A centralised computer shutdown software programme was installed to power down IT equipment when not in use.
Relationship to STREAMER	All initiatives deployed at GAST are considered as part of STREAMER.
WP7 partner	TRF/ARU

Guy's and St.Thomas' are two large hospitals based in the centre of London and together form the huge Guy's & St. Thomas' NHS Trust or GAST. GAST spent more than £10m on energy in 2004 alone but over the last 3 years they have achieved a 20% year on year reduction and cut energy bills by £1.7m.

The savings are due to:

- Installation of the largest CHP in the NHS
- Upgrading of boilers
- Insulation of pipes and valves
- Updates to the on-site catering and laundry facilities
- Improvements to heating and lighting controls
- Extension of BMS to previously unconnected areas

The CHP will reduce CO_2 emissions by 11,300 tonnes per year and save more than £1.5m in energy costs. In 2008/09 the carbon emissions due to gas were 21,000 tonnes and 50,000 tonnes for electricity. The engine has an electrical output of 3.041 MWe. Heat is recovered from the engine water system of 1,449 kW via an interface plate heat exchanger. The exhaust gases from the engine are supplied to a high temperature hot water waste heat boiler with a steam output of 1,400 kW and LTHW (Low Temperature Hot Water) of 1,333 kW at 82^{o}C.

A Jenbacher JMS620 gas engine with a Cochran waste heat steam boiler was also installed to work alongside the 4 existing boilers at St. Thomas' hospital. The hot water circuit from the engine supplies heated water via a plate heat exchanger for use across the hospital, whilst the exhaust gases are utilised via a catalytic converter to heat the newly installed lead boiler.

Heating and lighting controls feature prominently in the future projects along with a software package that will shut down PCs after a period of sustained inactivity.
Over the next 2 years the measures to be implemented are:

- Installation of motion detectors for lighting
- Inverters fitted to large supply and extract systems
- Upgrading of T12 and T8 fluorescent fittings to LED
- Power factor correction
- Staff awareness campaign

The images show IT equipment that could be powered down along with State of the Art heating and lighting controls.

3.2.8 Musgrave Park Hospital, Somerset

TITLE	*Musgrove Park Hospital, Taunton*
Reference	The Guardian Newspaper
Status	Publicly available
Language	English
Outline	The Guardian Newspaper has run as series of articles highlighting the energy use within the National Health Service of the United Kingdom. The report highlights initiatives undertaken to reduce energy consumption
Relevance	Hospitals can save lives but be bad for the health of the planet. Often environmentally unfriendly, energy inefficient and hemorrhaging money in fuel and electricity bills as a result. Most were constructed in the days when green was just a colour.
Summary	Musgrove Hospital in Taunton claims to have become the first hospital in the UK to pursue the "green dream" through private finance, paying off a capital loan from Schneider Electric with the money that the energy management firm helps it save on its. Before energy saving technologies are fitted and equipment upgraded, the hospital is making as energy efficient as possible. The Trust is replacing pipe insulation, improving steam and hot water distribution and modifying air conditioning systems to switch off when rooms are not in use. Running parallel is a capital development programme that will see old wards replaced by hi-tec new buildings.
Relationship to STREAMER	State of the Art building controls including occupancy sensors, time scheduling and automated temperature adjustment. New buildings incorporating State of the Art Energy Efficient Buildings (EeB) technology.
Additional comments	National government has set targets; mandatory carbon reduction goals of 10% by 2015, 34% by 2020 and 80% by 2050
WP7 partner	TRF/ARU

Musgrave Park Hospital has embarked upon a pioneering Energy Partnership with Schneider Electric. It is a pioneering project and the first of its kind in the UK health sector, providing bespoke financial funding. The project is being funded through a £72m capital investment provided by Schneider Electric through a 12 year capital borrowing facility, which includes energy monitoring and is backed by a long term performance guarantee.

It is fully self-funding with the costs of replacing old energy inefficient infrastructure, equipment and £2.5m in essential Estates projects financed by the fuel savings achieved. This means there is zero cost to the tax payer. The benefits of the project are:

- £17m in savings over 20 years
- Implementation of 180 technical solutions
- Fully self-funding project
- Replaces old energy-inefficient infrastructure
- Energy savings will fund £2.5m of essential Estates projects
- Zero cost to the tax payer
- Reduces average energy consumption by 40%
- Reduces carbon emissions by 43%
- Large reduction in maintenance costs
- Minimized business risk from energy price volatility
- Cash free up to invest in other Estates projects
- Provides more control over Estates operating systems and energy costs

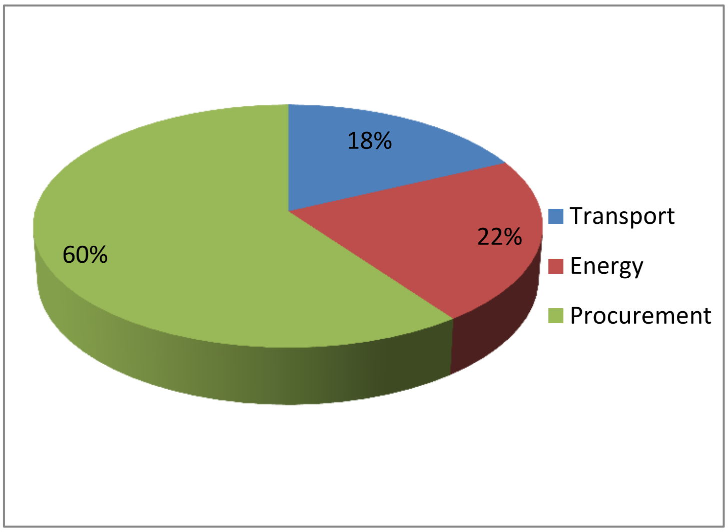
The project will include a CHP unit linking the Low Temperature Hot Water (LTHW) output to plate heat exchangers on several domestic hot water circuits and the addition of new energy efficient boilers to replace steam boilers at the end of their useful lives.

Steam traps will also be replaced and general repair and maintenance of the steam distribution system will also take place in addition to the replacement of calorifiers with plate heat exchangers.
The project will also encompass a full overhaul of the HVAC system including variable speed drives and control on air handling units and pumps as well as free cooling alterations to remove mechanical cooling requirements.

Additional measures undertaken will include improved metering and monitoring of electricity, gas and steam, Building Management System upgrades and the use of voltaic.
State of the Art building controls, replacement of pipe insulation (particularly on valves that have previously been missed) and presence detectors to control ventilation systems are measures that are being implemented. The images below show insulation of main heating valves and ventilation systems that are controlled via absence and presence detection.

3.3 Energy efficiency current practices at UK hospitals

3.3.1 Analysis of current status of energy use and energy supply mix



Building energy use is responsible for around 22% of all emissions within the NHS. Energy and carbon reduction targets are well publicised and each NHS organisation will have their own local targets. TRF currently procures its energy via the Government Framework of Crown Commercial Services (CCS) where electricity is provided via 100% green methods. The majority of NHS organisations use this framework so the total carbon emissions attributable to the burning of fossil fuels are greatly reduced. The energy mix sees that fossil fuels remain a huge source of main energy provision but around 65% of electricity provided to the NHS is via renewable or Good Quality CHP (QUIPP report 2012). No one fuel source provides all the answers, each has limitations: fossil fuels put too much carbon dioxide into the atmosphere and will eventually run out; nuclear energy creates radioactive waste; renewables like wind and solar are intermittent and expensive; and many generating technologies suffer from a lack of suitable sites, lengthy planning and approval procedures or insufficient industrial capacity. But the challenge of the energy gap is by no means insurmountable. Used together, different generating technologies have individual strengths that help to make up for each other's weaknesses. Sustained action on energy efficiency, demand management, a smart grid and a diverse energy mix encompassing renewables, fossil fuel generation fitted with carbon capture and storage and nuclear power should help to ensure low-carbon, secure, affordable electricity supplies for the UK for decades to come.

3.3.2 Energy Efficiency potential in UK hospitals

UK hospitals have a varied energy mix and each individual site can present a different opportunity to establish savings in energy. For instance; gas, electricity, bio fuels, oil, solar and other means can all offer many opportunities to become more efficient.

The NHS publication "*Saving Carbon, Improving Health*" showcased many areas and initiatives aimed at reducing building related carbon emissions, and subsequent targets (previously listed) were set to provide proof of positive action.

3.3.2.1 Building Optimisation

Energy efficiency can be achieved by rationalisation of the estate. By mothballing or demolishing older and energy inefficient areas, considerable energy savings are possible. Many Estates Directorates are looking at reducing the Gross Internal Floor Area by consolidating services into a main building instead of housing them in an older outbuilding. The Building Envelope can provide several options to improve energy efficiency.

- Solar Shading – solar shading systems can deliver distinctive architectural impact whilst cutting energy use. The benefits of natural daylight entering a building are obvious and people respond better when they have a view of the outside. Solar shading systems offer optimum performance by reducing solar gains whilst maintaining acceptable levels of natural daylight. They provide a reduction of cooling loads in the summer and heating requirements in the winter. With the drive towards energy reduction a key objective for use of solar shading is to maximise the use of natural light without the problems of glare or excessive solar heat gain.
- External Cladding – cladding is the application of one material over another to provide a skin or layer intended to prevent the infiltration of weather elements. It is now common to provide insulated cladding materials that will assist in retaining the heat within the building. Alternatively, an insulated product may be inserted between the two materials. Sizeable energy savings can be achieved using cladding.
- Insulation – insulation applied to either the outer or inner walls of a building will improve the thermal efficiency of the design. On many buildings there is generally a cavity between the inner and outer walls. An insulating product is utilised to fill in this gap and provide maximum thermal efficiency. Large savings on heating costs are common place when additional cavity or wall insulation is fitted.

3.3.2.2 IT Infrastructure Rationalisation

IT rationalisation analyses the potential for hospitals to simplify, standardise and consolidate their current server environment and develop an approach for migration to a strategic platform, whilst identifying sustainable and recurrent IT cost savings. As a result, hospitals can identify quick win hardware and software maintenance reductions that improve the content management capability while reducing the associated costs. At this time TRF are considering the installation of an IT services power management software solution. PCs left running continuously cost the NHS over £80 million a year with an estimated 30% of PCs left on overnight. These are challenging times, driving cost saving initiatives that need to have an ROI in months not years. PCs make up over 40% of IT consumption and there are applications available that can remotely interrogate the state of any PC on the network to determine how long it is switched on for and more importantly what percentage of that time it is actually being used. The software package provides an accurate baseline figure of PC power usage which allows hospitals to identify the savings to be made and take action by applying power saving policies. The IT power management software also has the ability to remotely shutdown and wake PC clients and intelligently saves and reloads applications and documents independently of any third party products (such as Microsoft SCCM).

3.3.2.3 Voltage Optimisation (VO) & Super-Efficient Transformers

Electricity must be supplied at levels between 230V plus 10% (253V) and 230V minus 10% (217V). All electrical equipment must be able to operate between these voltages; however, to obtain optimum efficiency and raise the lifespan of electrical equipment the voltage can be set at a lower level than 230V.

As a solution, VO products are available that can assist in achieving the required result for any particular site. There are tried and tested products using innovative technology to reduce overall kWh consumption, resulting in reaching the desired monetary and carbon savings. VO can result in a high level of energy saving without damaging sensitive equipment. At the present time TRF are looking into the possibility of swapping out existing aged transformers for Super Low Loss transformers. These transformers operate at an efficiency of 98%+, compared to efficiencies of between 70-80% on previous models. These transformers also offer automatic voltage adjustment dependent upon variations in the supply, thereby making the need for a separate VO unit unnecessary.

3.3.2.4 Smart Grids / Demand Response

The recent increase in distributed generation projects installed across Europe, predominantly Solar PV and Wind power generation, has started to have a detrimental effect on the grid in many countries. In simple terms, grid voltage/frequency is being adversely affected as the ratio of distributed generation to centralised generation increases. Similar grid problems are starting to occur in the UK and it is widely expected that legislation along the lines introduced in Europe will soon be adopted here. A highly innovative solution to assist this issue; Smart Grid, has been developed. Smart Grid allows electricity produced by generation schemes to be stored when they are disconnected from the grid, and then discharged when the connection is restored.

At present, it is possible to participate in schemes with the District Network Operator (DNO) where on-site generation can be exported back into the grid. The DNO dictates when this event is required and an automatic run signal is sent to the on-site generation (e.g. CHP). The benefit to the hospital is that they firstly receive a continuing payment for being available to export, secondly they receive a payment for the actual electricity exported and finally they make cost savings due to not importing electricity from the supplier. Another innovation in this field is STOR (Short Term Operating Reserve) or DR Demand Response. In this instance an organisation that has on site generation can be called upon by the DNO to switch to generated power, thereby reducing the demand upon the grid at busy times. TRF have just completed the initiation of this process and expect the system to be active by November 2014. When the DNO experiences high levels of demand, provided the hospital can cope with switching to generated power, an automated signal is sent and the generator is started automatically. A payment is received for being on standby and a further payment when an “event” is called. So for the cost of generator fuel there is benefit to TRF for being available to shed load from the grid. An added benefit of this initiative is that due to this periodic event the need for test running of the generator is eliminated, so saving on Estates resources.

3.3.2.5 Renewable Technology

The incentive to use 100% renewable energy for electricity, transport or even total primary energy supply globally has been motivated by global warming and other ecological as well as economic concerns. There are several different renewable options including sunlight, wind, rain, tides, geothermal heat, biofuels, biogas and traditional biomass.

- Solar Photo Voltaic – It is sensible to start with solar power, as it is both the most popular and most reliable renewable technology. Solar panel electricity systems, which are also known as solar photovoltaics (PV), capture the sun's energy using photovoltaic cells. These cells don't need direct sunlight to work – they can still generate some electricity on a cloudy day. The cells convert the sunlight into electricity, which can be used to run equipment and lighting. The UK is amongst the top 10 countries introducing electricity generated by the sun. It is a fast growing technology doubling its worldwide installed capacity every 2-3 years. In recent years concentrated photovoltaics (CPV) technology has improved its electricity generating efficiency, reducing the installation cost per watt as well as its payback time, and has reached grid parity in at least 19 different markets by 2014. In 2014 global photovoltaic capacity is estimated to increase by another 45 GW (Giga Watts). By 2018 worldwide capacity is projected to reach as much as 430 GW. This corresponds to a tripling within 5 years. Solar power is expected to become the world's largest source of electricity by 2050, with solar PV and solar thermal contributing 16% and 11% respectively. Solar PV will cut electricity bills: sunlight is free, so once the initial installation has been paid the electricity costs will be reduced. Payment is received for the electricity generated: the government's Feed-In Tariffs pay for the electricity generated, even if it is being used by the organisation that has generated it. Electricity can be sold back to the grid if the system is producing more electricity than is needed, or if it can't be used, the surplus can still be sold back to the grid.

- Solar thermal - harnesses the solar energy to generate thermal energy for use in the industrial, residential and commercial sectors. Although not in widespread use these installations are very popular for smaller installations, and can provide a very rapid payback provided all the circumstances are favourable.
- Wind Turbines – Wind turbines harness the power of the wind and use it to generate electricity. Forty percent of all the wind energy in Europe blows over the UK, making it an ideal country for domestic turbines (known as 'micro wind' or 'small-wind' turbines). A typical system in an exposed site could easily generate more power than the lights and electrical equipment would use. Wind electricity is green, renewable energy and doesn't release any harmful carbon dioxide or other pollutants.
- Heat Pumps – Geothermal energy is from thermal energy generated and stored in the earth. Thermal energy is the energy that determines the temperature of matter.
- Ground Source Heat Pumps – A Ground Source Heat Pump (GSHP) is a central heating and / or cooling system that transfers heat to or from the ground. It uses the earth as a heat source (in winter) or a heat sink (in summer). This design takes advantage of the moderate temperatures in the ground to boost efficiency and reduces costs of heating and cooling systems, and may be combined with solar heating (Solar Thermal) to form a geo-solar system with even greater efficiency. GSHPs harvest heat absorbed at the earth's surface from solar energy. The temperature in the ground below 6 meters (20 feet) is roughly equal to the mean annual air temperature at that latitude at the surface.
- Air Source Heat Pumps – an Air Source Heat Pump (ASHP) is a system which transfers heat from outside to inside a building or vice versa. An ASHP uses a refrigerant system involving a compressor and condenser to absorb heat at one place and release it at another. They can be used as a space heater or cooler. The ASHP absorbs heat from outside air and releases it inside the building either as hot air, hot water-filled radiators, underfloor heating and domestic hot water supply. The same system can often do the reverse in the summer, cooling the inside of the house.
- Biomass - The use of biomass in heating systems is beneficial because it uses agricultural, forest, urban and industrial residues and waste to produce heat and electricity with less effect on the environment than fossil fuels. Wood remains the largest biomass energy source today. Examples include forest residues such as dead trees, branches and tree stumps, yard clippings, wood chips and even municipal solid waste. This type of energy production has a limited long term effect upon the environment because the carbon in biomass is part of the natural carbon cycle; while the carbon in fossil fuels is not and

permanently adds carbon to the environment when burned for fuel (carbon footprint). Biomass boilers offer an environmentally sound heating solution. Burning biomass, such as wood pellets, wood chips or logs, emits the same amount of carbon dioxide as is absorbed while the plants were growing. Therefore, biomass is classed as a carbon neutral renewable energy. Biomass boilers burn biomass fuels extremely efficiently and use the heat produced to provide heating and hot water.

- Biofuels – as an energy source biomass can either be used directly via combustion to produce heat, or indirectly, it can be converted into fibres or other industrial chemicals, including biofuel. Conversion of biomass to biofuel can be achieved by different methods which are broadly classified into: thermal; chemical and biochemical methods. This biomass conversion can result in fuel in solid, liquid or gas form. Biofuels have increased in popularity because of rising oil prices and the need for energy security. Liquid biofuels include bio-alcohols such as bioethanol and oils such as biodiesel. Gaseous fuels include biogas, landfill gas and synthetic gas.

3.3.2.6 Power

- Lighting accounts for around 23% of building energy use (Carbon Trust) and the greatest potential for energy reduction and savings lies with improvements to existing fluorescent lighting. TRF are replacing obsolete T12 fluorescents with energy efficient T5 fittings or LED panels. A total of 1235, 58Watt T12 fluorescents have been replaced with 35Watt T5 fluorescents on a like for like basis, resulting in an energy reduction of 39,520Watts (48%). A total of 138, 600x600mm modular panels (4 x 18Watts) have been replaced with an LED sky tile (40Watts). The resulting energy saving is around 5,630 Watts (49%). A further benefit is that these LEDs not only offer huge energy savings but the amount of fittings required is greatly reduced and the maintenance costs associated with re-lamping, ballast replacement, etc. are saved as the LED panels are maintenance free. It is envisaged that ALL of the 600x600 modular fluorescents at the hospital will be replaced with LED panels within the next 2 years, providing a huge saving both in energy and maintenance costs. Intelligent controls such as presence detection, absence detection, daylight sensing and timers can be utilised to produce even more attractive benefits. TRF will also investigate the possibility of replacing all existing external site lighting, currently a combination of SON and Metal Halide, with an LED alternative. This should result in at least a 50% energy saving and major savings in maintenance time and replacement lamps.
- Energy efficient equipment or energy efficiency implementation is a means where organisations either retrofit or replace inefficient equipment with more efficient parts or equipment with the goal of reducing energy consumption. Retrofitting enhances existing equipment by making it expend less energy whilst a replacement or refurbishment of existing equipment or material will involve using the latest technology and components in order to reduce energy consumption. Most replacement equipment also now has to meet stringent carbon emissions guidelines and has to comply with carbon rating A or B on a scale ranging from A to E (A being the most environmentally friendly). Variable Speed Drives (VSDs) are a perfect example in the incorporation of energy efficient equipment is the use of VSDs. VSDs and inverters allow speed control of a motor (usually for air handling or pumping duties) to be achieved. It may involve replacing an existing motor with one capable of being slowed down to such a degree that torque and cooling fan operation are not an issue. Reducing the speed of a large air handling motor (e.g. lowering the frequency from 50 Hz down to 42 Hz) can result in substantial savings.

3.3.2.7 Heating, Ventilation & Air Conditioning (HVAC)

- Heating – The greatest potential for energy reduction and savings lies with improvements to heating software and hardware. The Carbon Trust estimate that up 20% savings can be achieved through installation of smarter controls, scheduling, programming and improved controls. A control strategy utilising outside air temperature sensors to automatically switch heating circuits on and off will provide further savings. By replacing old and inefficient hardware (valves and actuators) and installing more strategically placed temperature sensors additional savings are possible. TRF are presently undergoing a programme of upgrading both heating hardware and software, including installation of additional controls and temperature sensors, replacement of valves and actuators and upgrade of pneumatic controls on air handling units. There is still much to do but savings are already being seen, and improvements in the DEC scores on all sites are being noted.
- Underfloor heating – Underfloor heating works by pumping a controlled flow of warm water from any heat source through tubing embedded in the floor. Because the emitting area is large sufficient warmth is provided even on a cold winter day with no need for supplementary heating. It is possible to have an electric underfloor heating system as an alternative to a water underfloor heating system. If the dry system is used a series of electric wires are installed beneath or within the flooring. Savings are pretty modest compared to the cost of installation but nonetheless a ROI within 8 years is usually possible.
- Cooling – air-conditioning is the process of altering the properties of air (primarily temperature and humidity), to more favourable conditions, typically with the aim of distributing the conditioned air to an occupied space to improve thermal comfort and indoor air quality. The downside to air-conditioning is that it is usually quite expensive to run. Free / Evaporative Cooling – in common use, an air-conditioning unit is a device that lowers the air temperature. The cooling is typically achieved through a refrigeration cycle but sometimes Evaporative or Free Cooling is used. An Evaporative Cooler is a device that draws outside air through a wet pad. Evaporative coolers rely on the outside air to be channelled through the cooler pads that cool the air before it reaches the inside. This cooled outside air pushes the warmer air within the building out through an exhaust opening. The coolers cost less to run than a conventional air-conditioning system and energy savings of up to 90% have been recorded. TRF has just commenced installation of a Free Cooling system for its server room in the IT Centre and expects to save approx. 85% on energy costs compared to the existing server room cooling.
- Absorption Chillers – water chillers are used in a variety of air-conditioning and process cooling applications. They are used to make cold water that can be transported throughout a facility using pumps and pipes. This cold water can be passed through the tubes of coils to cool the air in an air-conditioning application, or it can be used to provide cooling for a manufacturing or industrial process.

3.3.2.8 Combined Heat & Power (CHP)

A CHP integrates the production of usable heat and power in one single highly efficient process. CHP generates electricity whilst also capturing usable heat that is produced in this process. This means that the overall efficiencies of CHP plants can reach in excess of 80% at the point of use. CHP plants provide local heat and electricity so that the site heating and hot water systems can be supplemented, resulting in less heating fuel being bought in. The generation of electricity is usually enough to serve the base load of the site and any excess capacity can be exported to the supplier providing a further source of revenue. TRF has had a CHP running on site since 2008 and this machine can generate up to 66% of the site load. The waste heat produced supplements around 53% of the site heating and hot water. It is estimated that the CHP accounts for an annual saving of over 4million kWh of electricity and almost 19 million kWh of gas, resulting in a reduction of more than 1,800 tonnes of CO_2 per year.

3.3.2.9 Awareness

Raising awareness amongst staff is a major part of energy reduction but is often overlooked when developing an energy strategy. By educating and training the end user and instilling an energy-reducing ethos large reductions and savings can be made. The Carbon Trust estimates that a large organisation can achieve savings of between 5-10% through staff engagement and raising awareness. Local campaigns should be rolled out on a regular basis and Environmental / Energy Champions recruited to create a two-way stream of information that will highlight both good and bad practice. Publicity via local communications, posters, roadshows, competitions, and quizzes has proved successful in raising staff awareness. Annual energy awareness training sessions are rolled out to staff on an ad-hoc basis as part of a complete waste and energy training package, tied in with other mandatory and statutory training. A network of Environmental Champions has been established for many years where members of staff are encouraged to become involved. Motivated individuals attend quarterly Champions meetings providing a two way exchange of both good and bad practice and helping to raise awareness in their own areas of work.

3.4 The vision – NHS projects

The NHS in the UK has challenging targets set for energy reduction on three levels. Firstly, there is government driven legislation in the form of the Carbon Reduction Commitment Energy Efficiency Scheme (CRC EES) where large organisations must pay a levy for every tonne of carbon emitted due to their business activities. Secondly, the NHS Sustainable Development Unit (NHS SDU), having carried out extensive research, formulated carbon reduction targets up to 2050, with milestones targets featuring regularly along the way. Finally, NHS organisations will set their own local targets for carbon reduction against a baseline year (usually 2008/09).

As a result of the three levels of targets, NHS organisations are obliged to identify and implement energy and carbon reducing initiatives that will meet the targets set. Different organisations will design their own action plans and identify the projects that are most relevant to them.

3.4.1 Long and short term goals

It is important to set short term targets with long term goals. Annual Key Performance Indicators (KPIs) should be calculated where current performance can be assessed alongside longer term aims. It is intended that all NHS Trusts will show a reduction in the consumption of fossil fuels and this is quantifiable by examination of annual returns to the UK government each year (ERIC Returns). The philosophy is that if the short term targets are being achieved then the long term goals will also be achieved.

Many NHS Trusts participated in a Carbon Management Programme, where, working with the Carbon Trust, a Carbon Management Plan would be formulated for each individual Trust where energy / carbon reducing projects would be identified and implemented if they were deemed to be appropriate. Funding streams were also available in some cases offering attractive loan repayment rates. Many NHS Trusts have taken advantage of this and are beginning to show marked reduction in carbon and energy.

3.4.2 Corporate & Social Responsibility (CSR)

All NHS organisations have a responsibility to provide an ethical corporate means of delivering the provision of healthcare. CSR is a form of corporate self-regulation integrated into a business model. In some models, an organisation's implementation of CSR goes beyond compliance and engages in "actions that appear to further some social good, beyond the interests of the organisation and the requirement of the law". CSR is a process with the aim to embrace responsibility for the organisation's actions and encourage a positive impact through its activities on the environment, consumers, employees, communities, stakeholders and all other members of the public sphere who may also be considered stakeholders. In this regard, being a responsible environmentally friendly organisation and appearing as an exemplar organisation to local business, councils and communities is of

great importance. In this regard the NHS can take the lead and be held up as the way forward in showing best practice.

3.5 Conclusions

When considering improvements, alterations and additions to healthcare buildings many factors should be examined closely. To achieve the desired energy efficient outcome there are many options available, but each site is individual so every case must be investigated separately and judged on its own merits. What works for one site or organisation may not necessarily work for another. It is important to understand which initiatives will provide the optimum outcome. Given that the energy costs of the entire NHS Estates total more than £500m, costs and methods of financing schemes will also be a major consideration for each hospital. There are many drivers for improving building energy efficiency:

- Financial savings
- Compliance with legislation
- Meeting national, NHS or governmental carbon targets
- Meeting international targets
- Meeting local targets
- Taking Corporate & Social Responsibility obligations seriously
- Aiming to stand out as an exemplar organisation
- Favourable publicity

There are countless means of making improvements to a building's energy consumption. These include:

- Improvements to the building fabric and façade (brise soleil, solar shading, external cladding, solar window film etc.)
- Cavity insulation
- Double / triple glazing
- Pipe insulation
- Underfloor heating
- Energy efficient lighting
- Daylight dimming / intuitive controls
- Absence and presence detection for both lighting and heating / ventilation
- Smart heating controls and time scheduling
- Improvements to existing heating hardware and software
- Procurement of energy efficient equipment
- Power management of IT equipment
- Variable Speed Drives on air handling equipment and pumps
- Utilisation of a CHP system
- Renewable energy options (e.g. solar PV, wind turbine)
- Voltage optimisers
- Raising of staff awareness / staff engagement

The final point above of staff awareness and engagement is not always seriously considered but should not be overlooked. If buy-in from the end users can be achieved then building energy use will certainly decrease.

From the perspective of TRF, project STREAMER was always intended to provide a reasonably accurate tool that would enable considered decision making based upon a theoretical model developed with the help of real energy and building data.

By utilizing this model a variety of interventions may be applied with a scientific energy outcome having been calculated. If it is deemed viable to apply a certain intervention, then the resultant (metered) energy saving can then be aligned alongside the calculated figure and the results appraised. This would then validate the model, or otherwise.

Once confidence has been established in this model it would then become the template for a whole range of retrofitted building improvements and provide a "retrofitting blueprint" for similar buildings in the NHS on a nationwide scale. State of the Art Retrofitting solutions within the NHS would be a massive application for the modelling as there is relatively little new building construction in the UK at present. More than 70% of the NHS Estate is pre 1970s therefore making it imperative that the STREAMER project is successful regarding the modelling of existing buildings.

The STREAMER model could still also be applied to new buildings to ensure optimum energy efficiency within the design and as time and technology advances the model will be amended on a dynamic basis to reflect actual performance, thus providing an accurate template.

It is essential that accurate metered data is collected for both electricity and gas consumption, for both area and whole site; therefore all areas in both existing and new buildings would need extensive metering. It is well known that NHS buildings do not generally have this level of metering, and even in cases where metering is available, regular readings are not gathered and the data is lost or unused. TRF has invested heavily in both electrical metering (down to circuit level) and heat metering for project STREAMER and if this proves beneficial metering may be rolled out site wide, finances permitting.

Finally, it would be prudent to carry out an in-depth study into the decision making process. Is it better to utilise an existing building or construct a new, environmentally friendly and energy efficient building? The BIM process and STREAMER conclusions and results would provide valuable data in this regard and an informed decision could then be made as to the preferred choice between retrofitting versus demolition and rebuild.

4. Italian section

4.1 Introduction

This section studies the state of the art in Italy regarding the energy efficiency practices in Italy for healthcare buildings. The Italian institutions, including healthcare districts, have performed many actions to reduce building energy consumption. Furthermore, many research projects are focusing on how to achieve reduce the environmental impact of buildings.

In the following sections, the Italian Hospitals that have made Energy Efficiency implementation are first surveyed; then, we list and briefly describe the national and local legislations related to the Energy Efficiency in Hospitals. Some foreign Guidelines, Conferences and Research Projects in Italy related to our study are briefly described, and finally, energy efficiency current practices (according to the WP2 classifications) are studied.

4.2 List of Italian Hospitals that have made Energy Efficiency implementation

4.2.1 Varzi Hospital (Pavia)

TITLE	Varzi Hospital (Pavia)
Reference	Provincia di Pavia – Variante PTCP 2012 Strategy document, Siram website
Status	Publicly available
Language	Italian and English
Outline	Planning document, Case studies on effective supply chain partnership
Relevance	In the first document, possible interventions to increase the energy efficiency of Varzi Hospital are presented through a SWOT analysis. Plants data and technical characteristics are summarized in the second reference.
Summary	Varzi Hospital is an important productive settlement structure situated in the interior of oltrePo Pavese. Varzi Hospital in 2011 has installed a biomass boiler fed by wood chips. ▪ The boiler has a capacity of 1,5 MWt, covering the yearly base load of heat and sanitary water needs ▪ 7.500 MWh of energy produced in a year ▪ 620,93 TONS of reduction of CO2 emissions ▪ District heating Storage silo capacity 348 m^3
Relationship to STREAMER	Among renewables, plants fed biomasses have the highest potential in terms of carbon dioxide emission reduction that is one of the main goals of STREAMER. From the Project Abstract: “STREAMER aims at 50% reduction of the energy use and carbon emission of new and retrofitted buildings in healthcare districts.” These plants are ideal for district-heating configurations as well especially when the wood supply chain is locally managed like in Varzi.
Additional comments	The biomass supply comes from local agriculture, max 15 km from the plant (short chain), using the Short Rotation Foresty.

	Maybe due to the recent economic crisis the hospital will have to close
WP7 partner	BEQ/AOC

4.2.2 Ospedale Unico Versilia

TITLE	**Ospedale Unico Versilia**
Reference	***http://www.usl12.toscana.it/*** ***http://www.arpat.toscana.it/notizie/arpatnews/2012/179-12/179-12-l2019ospedale-della-versilia-all2019avanguardia-dal-punto-di-vista-energetico***
Status	Publicly available
Language	Italian
Outline	The new Versilia hospital can be considered a good practice since it adopts new high efficiency technologies, such a modern cogeneration plant, and effectively manages the energy demand through smart control systems. In particular, Versilia Hospital is the first health facility in Italy that has been equipped with a Capstone turbine C600, an innovative Combined Heat and Power (CHP) plant.
Relevance	The problems linked to hospitals growing energy needs have been one of the main issues during the design of the new building, considering how a poor use of energy not only produces an exponential increase in operating costs, but also results in a less comfortable environment for patients and visitors. The proper control and management of plant operation is second only to the structural one as a source of energy saving. The concept of appropriateness, widely used for health services, should be extended to the use and supply of energy to the different areas of the hospital building for heating and electricity. Today, this function can be facilitated by means of modern plant control systems and technological systems available in hospitals. In Versilia hospital's thermal station interventions were made aimed at optimizing the hot water generators and distribution of chilled and hot fluid (punctual balancing) with significant improvements in terms of comfort. Great attention was paid to the CHP (co-generation) plant, the efficiency of heat recovery plants and the improving the plan of use, including rationalization of heat recovery for cogeneration, which reduces the operation of heat sinks to a minimum, have each contributed to the achievement of savings both in terms of energy and economy. The results from a different plant management, (especially the hot water generators and CHPs) have been immediate and have substantially helped to produce major cost savings. (2004 / 2007: -27.6%).
Summary	Versilia Hospital is the first hospital in Italy that has an Energy Class B. In 2002 installed a Capstone C600 Turbine used in a CHP plant. ▪ 600 kWel power output from the Capstone turbine ▪ 210 TEP of reduction ▪ 600 TONS of CO_2 emissions (declared by the hospital) ▪ In 8 years reduction of 30% energy ▪ Turbo cooling and oil – free technology ▪ < 9 ppmV di NOx emissions into the atmosphere ▪ Building orientation along the east-west axis

	▪ a “tree wall” used as to reduce direct sunlight ▪ attention to construction materials to obtain an increased thermal inertia of the building mitigation of solar radiation by means of structural finishes ▪ 630 kg / h of steam at 8 bar and 400 kW of hot water at 90 ° C, prepared for the use of an application of "turbo-cooling" that serves to condition the combustion air turbine by installing a refrigerator absorption which transforms part of the thermal energy of waste of the turbine itself in cooling energy, used to maintain the gas turbine in technical conditions of operation "ISO" and that is to maximum performance in any condition of the outside temperature.
Relationship to STREAMER	This case study is important since the innovative plant configuration provides large benefits in terms of pollutant and greenhouse gases (GHG) abatement that can be obtained throughout these systems operation. One of the main goals of STREAMER is in fact to will enable designers, contractors, clients and end users to integrate EeB innovations for medical, MEP and HVAC systems and the related neighbourhood energy grids. Examples and good practice such the one in Viareggio help in the discovering of the potential especially of cogenerators in the energy management of hospital facilities.
Additional comments	Seven municipalities have participated in the project financing of the project.
WP7 partner	BEQ/AOC

4.2.3 Presidio Ospedaliero Maggiore, Chieri

TITLE	Presidio Ospedaliero Maggiore, Chieri
Reference	***http://www.anmdo.org/wp-content/uploads/Messori1.pdf*** For the health of "Class A": the first step towards eco sustainability of the Hospital "Maggiore" of Chieri (ASL to5 - Piedmont Region)
Status	Publicly available
Language	Italian
Outline	Contains guidelines used to make eco-friendly hospital; ▪ reducing atmospheric emissions; ▪ imitating the exploitation of primary resources; ▪ protection from overheating in the summer; ▪ Ventilation and air quality; ▪ Limiting the use of air conditioning; ▪ Better use of natural light.
Relevance	The hospital has the goal of achieving a classification efficiency class A
Summary	To achieve these goals, in Chieri hospital they have considered whether to adopt a wide range of technical solutions: ▪ improving the thermal insulation of the building envelope, ▪ fixtures and glass panels with high quality and performance ▪ control and management of the lighting and ventilation of natural and man-made ▪ solar panels, ▪ elements of natural light from above (sun-pipes) and transparent pyramids, ▪ flat roofs and walls in the garden (green roof) ▪ radiant floors or ceilings, ▪ condensing boilers, ▪ BMS control systems, quality and environmental comfort, ▪ Provide for the recovery of the water.
Relationship to STREAMER	This can be considered one of the most shining examples at least in Italy. The holistic approach built over the three pillars energy efficiency, indoor comfort and innovation in the hospital technologies, has leaded to this important class A certification, underlining the importance of BIM in the integration of such complex matters. This is what STREAMER wants to obtain, the challenge is to find parameters that will allow achieving the same positive goals in different contexts.
Additional comments	The challenge is to get out of the hospital only on the application of rules, but to adopt a pro-active methodology in integrated assessment. socio-economic setting goals that have result of long-term
WP7 partner	BEQ/AOC

4.2.4 Fondazione Ca' Granda Policlinico, Milano

Title	Fondazione Ca' Granda Policlinico, Milano
Reference	Conference proceedings http://www.enea.it/it/enea_informa/events/efficienza-energetica-ospedali_28-29feb12/5118D21.pdf
Status	Publicly available and private documents
Language	Italian
Outline	The new plant of the Foundation Ca' Granda Hospital is able to simultaneously produce electricity, heat and cool. The new trigeneration plant will enable significant energy savings for the hospital and the reduction of carbon dioxide emissions.
Relevance	Last but not least, innovation is accompanied by a substantial saving on energy expenditure and management systems, optimizing the operating costs of ordinary and extraordinary.
Summary	In particular, the estimated energy savings should be greater than 1,060 MWh / year. In addition, compared to a 2% reduction in primary energy demand, it is estimated a 15% reduction in carbon dioxide emissions. The new configuration of the control panel allows for a reduction in carbon dioxide emissions by about 836 tonnes per year (equivalent to the emissions produced by 400 diesel cars per day, 250 days a year, covering 12 km). The new building replaces all the individual plants in the area of the Foundation, with the exception of those in Office Building and Peace Street. Thanks to the central tri-generation plant and related control systems that can monitor and manage the entire energy needs of the Hospital, the Hospital will have a single source of thermal energy, an additional source of electricity and a source partial cooling energy. The cogeneration system allows producing electricity and heat generation in the same process. The produced heat is recovered downstream of the process of production of electrical energy. A further implementation of cogeneration is the tri-generation through which a plant produces power, heat and cold, in accordance to the demand coming from the served end user: during the hot season, in fact, cooling is provided by recovering wasted heat from the CHP, through an absorption refrigeration chiller. The new plant, in addition to improving the ability to cope with the increasing need for electricity-dependent evolving health care facilities independently by the external electric power, will improve the reliability and functionality of the production and distribution of energy, drastically reducing, in the first place, the risk of blackouts. In addition, a substantial improvement of the aspects of safety, reliability and environmental compatibility, from a high and verifiable reduction of atmospheric emissions of combustion products, thanks to the use and exploitation of renewable or assimilated.
Relationship to STREAMER	This project in Milano has a strong connection to the issues of innovative technologies, primary energy savings and emissions reductions that are one of the main pillars of STREAMER. It is stated in the same title of the Project, in fact, that STREAMER seeks a reduction of 50 % of the energy use and of carbon emissions, and the best way to get these targets is to retrofit existing pants with CHP or trigeneration units.
Additional comments	▪ Trigeneration plant ▪ 1,060 MWh / year of energy savings ▪ 5% reduction of primary energy demand ▪ 20% reduction of CO_2 (1,000 TON/year)
WP7 partner	BEQ/AOC

4.2.5 Sant'Orsola Hospital, Bologna

TITLE	Sant'Orsola Hospital, Bologna
Reference	http://www.comune.bologna.it/ambiente/servizi/6:6513/9719/
Status	Publicly available
Language	Italian
Outline	Restructuring and upgrading of the heating systems of energy production, Cchp, combined cooling, heating and power
Relevance	The relevance of the project is related to the potential in terms of energy savings of a retrofit of the existing plants of Sant'Orsola Hospital, the largest one of Bologna.
Summary	Trigeneration plant consists of two cogeneration engines to natural gas by more than 3.3 MW of electricity and 2.9 MW with two-stage cooling units from about 2 MW. In addition, it will be restored the current central value production. It will also renew the pipeline system that transports the heating and cooling of the central and hospital pavilions.
Relationship to STREAMER	Again, the potential in terms of energy savings of the interventions with the largest role of the CHP, leading to expectations of gaining a self-energy independence for the whole hospital with savings probably larger than the 50 % targeted in STREAMER.
Additional comments	▪ thermal power plant 52MWt ▪ steam power plant 15 MWt ▪ trigeneration power plant 15 MWt ▪ 27% reduction consumption ▪ 1.589 TONS of CO2 per year ▪ primary energy savings equal to 4.863 toe per year
WP7 partner	BEQ/AOC

4.2.6 Borgo val di Taro Hospital

TITLE	Borgo val di Taro Hospital
Reference	Rural development program action 3 – Aiel Italian association energy forest
Status	Publicly available
Language	Italian
Outline	Production of thermal energy with eco-sustainability and save environmental.
Relevance	Interesting good practice where energy efficiency is achieved thanks to a biomass plant whose chips fuel come from a zero kilometre short rotation forestry.
Summary	A new biomass boiler has been installed to provide heat to the hospital (Borgotaro is on the Apennines mountain so that there is not specific need for cooling. The plant is compliant to a future upgrade to install a power turbine, in order to shift towards a CHP plant configuration, but so far it operates just providing the thermal requirements of the health facility. The intervention shows a good economic feasibility allowing a general saving of more than 50 % of the primary energy needed to fulfil the whole hospital energy demand thank to the renewable fuel (the plant-chip, in fact, operate together with the backup existing thermal gas fired boiler). It has been installed an automatic ash removal, for cleaning of heat exchangers and for filtering. The management of the whole biomass supply chain is a part itself of the intervention in order to assure the necessary quantity of wood chips to the facility.
Relationship to STREAMER	Renewables and “district approach” in the energy supply are the pillars of this initiative, both are fundamentals in STREAMER.
Additional comments	▪ 1.539 MWh produced in a year ▪ Biomass boiler Uniconfort to 6 bar working pressure at 150C° ▪ 700 kW thermal power ▪ Generators for auxiliary heating needs during the winter months ▪ 696 kW boiler output ▪ 341 tons of CO_2 The structure of the boiler is self-supporting, made of sheet steel with high mechanical resistance externally coated material antiradiant high density. The combustion chamber is of type "to more smoke rounds" for optimum settling of dust contained in the combustion fumes. The heat exchanger "economizing" configuration has a "horizontal fire tube" with a special geometry that guarantees maximum efficiency.
WP7 partner	BEQ/AOC

4.2.7 Galliera Hospital (Genova)

TITLE	Galliera Hospital (Genova)
Reference	http://www.galliera.it/20/56/1154/file-articoli-inevidenza/Hospital-PublicHealth-lug-sett2011.pdf
Status	Publicly available and private documents
Language	Italian
Outline	Development and design of all facilities in hospital's service that will produce positive effects, emission reduction and energy saving.
Relevance	Sample of interventions focused on renewables, passive retrofit of the envelope, district heating. BIM model.
Summary	The planned interventions are: ▪ passive systems for energy savings: insulation, passive Solar ▪ insulation efficiency: cold heat and electricity ▪ energy recovery: heat exchangers ▪ district heating for the neighbouring district ▪ passive natural light ▪ automatic lighting control ▪ use of FER The technologies used for engineering design are object oriented and BIM.
Relationship to STREAMER	The interventions proposed perfectly suite with the STREAMER research, the fundamentals of the retrofit have been developed in sought of a significant energy saving and emissions abatement. Applications of BIM to these energy strategies confirm the potential of enhancing the benefits. Energy exchange with the neighbourhood within a district heating scheme represents a relevant reference and a significant good practice.
Additional comments	Have used the American guidelines " Green Guide for Health Care" http://www.gghc.org/about.whoweare.overview.php
WP7 partner	BEQ/AOC

4.2.8 Ospedali riuniti (Ancona)

TITLE	Ospedali riuniti (Ancona)
Reference	http://www.greenhospital-project.eu/the-partners/ospedali-riuniti-ancona/
Status	Publicly available
Language	English
Outline	Azienda Ospedailiera Universitaria (AOU) of Ospedali Uniti di Ancona is a University hospital and part of the National Health Service working in cooperation with Polytechnic University of Marche, Faculty of Medicine and Surgery. The faculty has long experience in international academic research whereas the hospital is the most important one of Marche Region
Relevance	First stone of hospital main building was posed in the 70's and since that period the building has had its own dynamic life (it has been enlarged and renewed several times). Its structure is very complex and, for this reason, it can be a perfect building to investigate the best ICT solutions assuring an energy saving.
Summary	Ancona hospital is the Italian part of a pilot project called AGORA. This project focuses on a strict control on indoor environmental thermal end energy parameters through gauges and digital systems. All the collected data are managed by a data centre that continuously examine the energy demand coming from the various monitored Department, optimizing hence the plant operation. AGORA can be considered an important reference experience for the findings of WP6 as well. Loccioni is the technological partner of the Ancona Hospital in the development of AGORA.
Relationship to STREAMER	All the applications that have been tested in this hospital perfectly match with STREAMER vision. Especially the AGORA protocol can give significant input to WP6 and, in general, to all the other task of the project.
Additional comments	Ospedali riuniti Ancona is partner and case study of a green hospital project The work carried on in the three years of the project is structured to reach six main scientific objectives listed below. The scientific objectives are: ▪ To develop a standard benchmarking model for energy measurement in hospital environment ▪ To develop and integrate a Web-EMCS ▪ To develop holistic control algorithms for energy consumption optimisation ▪ To implement and validate the proposed solution (Pilots) ▪ To implement a maintenance service ▪ To disseminate the project results and to educate users.
WP7 partner	BEQ/AOC

4.2.9 San Luigi Orbassano Hospital, Torino

TITLE	San Luigi Orbassano Hospital, Torino
Reference	http://www.smau.it/torino14/success_stories/smart-hospital-a-orbassano-energia-a-km-zero-dai-rifiuti-sanitari-il-caso-smart-city-ospedale-san-luigi-gonzaga-orbassano/ http://sitospa.it/attachments/article/130/Comunicato%20Stampa%20Convegno%203.12.12.pdf
Status	Publicly available
Language	Italian
Outline	First project in Italy which provides the use of the optimization of hospital waste.
Relevance	Smart Hospital project: pilot experience of the management of infectious and hazardous medical waste sterilization system external to the Hospital
Summary	Disposal of hospital waste in healthcare facilities is a problem, logistical and economic. The project involves the treatment of non-hazardous waste to make them and turn them in to non-fossil fuel at 0 km, in particular, the waste is cut, sterilized and aerated, the new system of treatment estimated operating costs of less than 15% 30%.
Relationship to STREAMER	The relevance of this project is mainly related to a plant retrofit scheme within zero-kilometre logic. The re-use of waste is compliant to the district approach, which is basic in STREAMER. Even though it is still controversial if the wastes energy processed should be considered renewable or not, the potential of this scheme is unquestionable.
Additional comments	▪ 1 gas-fired CHP ▪ 1 CHP fueled by vegetable oil ▪ A photovoltaic system ▪ A refrigeration unit with two absorption chillers ▪ Refrigerated centrifuge with high COP ▪ Power CHP 1000 kWe each ▪ 60 KWp photovoltaic system ▪ 1200 KWf power the refrigeration unit ▪ 3000 KWf power mini centrifugal
WP7 partner	BEQ/AOC

4.2.10 Gemelli General Hospital, Roma

TITLE	Gemelli General Hospital, Roma
Reference	http://www.Green@Hospital-project.eu/
Status	Publicly available
Language	English
Outline	Innovative technologies for sustainable building, reducing energy consumption through the use of renewable energy sources.
Relevance	Best practices
Summary	The project involves several steps in preparation for the redevelopment energy. First, check the state of systems and existing systems, after which an evaluation with economic and financial cost-benefit analysis to identify the lines of development and possible priorities for action, and finally a series of actions to energy retrofits, and maintenance of facilities and systems with the specific purpose to further define some guidelines and intervention.
Relationship to STREAMER	The goal of consumptions per square meter that has been targeted (25 kWh/m2) is very ambitious and perfectly meets the expected requirement of STREAMER aim: 50% reduction of the energy use.
Additional comments	The main goal is to reach a consumption of 25 kwh/mq year; this target can be reached through several actions such the use of renewable energy and high-efficiency systems, such as: i) a trigeneration system, able to produce electricity, hot water for heating and steam and cold water for air conditioning in summer, ii) ii) a diesel engine associated to a heat recovering section that provide steam and hot water to the end uses through a heat exchanger that recovers the heat in the exhausted gases of the engine. Finally by means of an absorption chillers (solution of lithium bromide typology), cold water is produced as well; The CHP can be fed by vegetable oils, canola, tobacco, sunflowers and soybeans
WP7 partner	BEQ/AOC

4.2.11 Sant’Agostino-Estense (Modena) -Local Health Authority

Title	Sant’Agostino-Estense (Modena) -Local Health Authority
Reference	Conference proceedings http://www.ausl.mo.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/10874
Status	Publicly available
Language	Italian
Outline	Considerable reduction of primary energy demand of the hospital through the installation of a CHP.
Relevance	Primary energy saving thanks to cogeneration is the main result of the intervention, Other relevant issues of the project are the actions put in force to obtain a full abatement of the noise impact from the new cogeneration engines. Two 'hoods' completely soundproofed have been implemented to reduce the noise of these systems.
Summary	The work of the hospital system began in 2012, was completed in mid-2014 and the results in terms of both economic and energy are already tangible.
Relationship to STREAMER	The installation of the new CHP results in a 25 % primary energy saving. This is relevant to the STREAMER target to halve the primary energy demand of the facility.
Additional comments	▪ 14% less emissions CO2 in year ▪ 2 endothermic cogenerations system (1.130 kW)
WP7 partner	BEQ/AOC

4.2.12 Brotzu (Cagliari) Local Health Authority

TITLE	Brotzu (Cagliari) Local Health Authority
Reference	PhD thesis, Francesco Valentino Caredda 2011/2012 Conference proceedings "Energy efficiency in hospital" http://www.enea.it/it/enea_informa/events/efficienza-energetica-ospedali_28-29feb12/5118D21.pdf
Status	Publicly available and private documents
Language	Italian
Outline	The Ph.D. thesis presents dynamic energy simulation carried on hospitals digital model, using TRNSYS and AOB carried. Findings are presented in terms of thermal energy requirements referred to each single floor and to the whole facility. An analysis of the peaks in demand has been carried out. The thesis finally examines some good practice to lower primary energy consumptions through specific energy saving measures.
Relevance	The study, starting from the reconstruction of a cognitive maximum of the current energy needs (electricity and heat) of the hospital, has identified some possible rationalization and improved efficiency in energy saving.
Summary	In particular, have been identified 4 actions to be taken on the structures of the hospital: ▪ Installation of solar panels to produce hot water on some covers of the main body of the hospital; ▪ Installation of solar photovoltaic panels to produce electricity on the flat roofs of detached body of the hospital; ▪ Optimization of the internal lighting system (replacement of electromagnetic ballasts that power the current fluorescent lamps with modern electronic ballasts) and external (substitution, replacing the existing mercury vapour lamps and metal halide vapour lamps, high pressure sodium) for the reduction of the costs of electricity ▪ Adjustment of the thermal insulation of flat roofs of the building principal, to reduce the cost of air-conditioned building.
Relationship to STREAMER	The theoretical approach for this study is coherent with the methodology adopted in STREAMER even though it is site specific and the BIM potential is not really investigated in the study.
Additional comments	The following lists the actions with the energy savings per year ▪ Solar thermal panels. 512 MWh thermal ▪ Solar panels: 77 MWhe ▪ Lighting System 358 MWh ▪ Heat insulation: 19 MWhe / 174 MWh thermal
WP7 partner	BEQ/AOC

4.3 Energy efficiency current practices at Italian hospitals

4.3.1 HVAC systems

TITLE	HVAC systems – current practices: Ventilation systems, Heating systems, Cooling systems considerations, Integrated heating, hot water production and AC
Reference	STREAMER Deliverable 2.1 http://project.demobv.nl/STREAMER/Shared%20Documents/Forms/AllItems.aspx?RootFolder=%2fSTREAMER%2fShared%20Documents%2f08%20WP2%2fDeliverable%202.1%20-%20review&FolderCTID=0x0120002E82D5CE50A8CC4589162F983428E5E1&SortField=Modified&SortDir=Asc&View={D47F4D17-40F2-4354-BE4B-A21F317014FC}
Status	Not applicable
Language	Not applicable
Outline	Not applicable
Relevance	Hospitals are the most energy intensive end users so that it is not rare than even small and medium facilities show the same overall consumptions of villages or small cities. The conservable energy demand is the direct cause of both the operation of the medical appliances and the necessity of controlling the indoor air temperature and humidity to levels compliant to the comfort of the occupants. HVAC plants are responsible of the highest weight in the energy balance of the hospitals: air systems operations, in particular, are associated to a huge energy demand, because of the necessity of high ventilation flow rate for hygienic reason. The possibility of enhancing the energy transformation processes efficiency even by a small percentage always results in a considerable energy savings. Moreover the good practice can be investigated and pursued both at building and district levels.
Summary	The European current practices in HVAC are listed and described in the STREAMER Deliverable 2.1. The Deliverable investigates the State-of-the-art review of all the HVAC plants normally operating in the hospital departments. The State of the Art analysis provides energy saving priority as well. Research is done for technologies that refer to the room and building level. Considerations about energy integrated neighbourhood systems are further discussed in Deliverable 2.7 and Deliverable 2.8. HVAC criteria for hospitals are different from country to country as they are stated either by national law either by technical requirements; besides, in many the hospital itself provides individual self-requirements to support performed treatments. Even though the energy savings can be done both at room level and building level, it is more effective to seek the energy efficiency of the processes with regards of the energy loads of homogeneous climate zone according which a certain department can be divided. The practice in plants management provided by D 2.1 can be taken as valid for the Italian facilities as well since their validity is general. Some basic actions are then suggested: • performance of motors should be measured regularly and serviced according to technical requirements; • the system efficiency distribution losses should be eliminated and all the ducts and pipes should be insulated properly; • ducts should be cleaned and maintain in good conditions to prevent air contamination and secure good air quality; • devices operation should be constantly monitored and controlled so

	their working point is always high placed on the efficiency curve Regarding the methodology, the HVAC technologies are then searched, selected and briefly described in Appendix 1 of the Deliverable, grouping them in accordance to their position in the energy supply chain. From the list it is clear that not all of them are HVAC. In the list that follows only HVAC have been selected. • Energy distribution technologies (i.e. Water circulation pump with variable speed, Hybrid ventilation Air ducts, ventilation and recirculation systems: • Energy delivery technologies(i.e. Electric heating; IR panels, Electric floor heating, ClimaRed® system, Water heating systems, Ultrasonic humidifier, Local heat recovery, Split air conditioner (Single and Multi) / AC – heat pump, Wall mounted local air conditioning unit, Cooling ceiling panels, Fan coil, Chilled Beam), • Energy storage technologies (i.e. Local buffer tank for DHW, Small Aquifer Thermal Energy Storage and Borehole Thermal Energy Storage ATES/BTES, Cold storage with ice/local storage); • Supporting technologies (i.e. Chemical disinfection of domestic hot water)
Relationship to STREAMER	Aim of the STREAMER project is to reduce the energy use by 50% and carbon emission of new and retrofitted buildings. HVAC represent hence one of the key target of the research since through their optimization it is possible to achieve the expected considerable benefits in terms of primary energy savings and pollutant and carbon emission abatement.
Additional comments	None
WP7 partner	BEQ/AOC

4.3.2 Electrical systems

TITLE	**Electrical systems – current practices: Lighting technologies, Elevators/Escalators**
Reference	STREAMER Deliverable 2.1 http://project.demobv.nl/STREAMER/Shared%20Documents/Forms/AllItems.aspx?RootFolder=%2fSTREAMER%2fShared%20Documents%2f08%20WP2%2fDeliverable%202.1%20-%20review&FolderCTID=0x0120002E82D5CE50A8CC4589162F983428E5E1&SortField=Modified&SortDir=Asc&View={D47F4D17-40F2-4354-BE4B-A21F317014FC}
Status	Not applicable
Language	Not applicable
Outline	Not applicable
Relevance	Electricity end uses represent a very energy-intensive final end uses in hospitals, especially in the facilities with large ventilation units installed. This is due to both the fans and, moreover, to the compressors that during the hot seasons provide cool to the cooling batteries of the ventilation units operating inverse thermodynamic cycles. This is particularly true for Italian hospitals; there is an abundant literature that demonstrates the existence of a strict correlation between ventilation unit operations and electricity consumptions especially in presence of operating theatres. The acknowledgement of the energy systems directly fed by electricity and of the typical best practice their associated in then pivotal in the research.
Summary	Again, the European current practices in electrical systems are listed and

	described in the STREAMER Deliverable 2.1. The Deliverable investigates the State-of-the-art review of the most important plants fed by electricity normally operating in the hospital departments. The State of the Art analysis provides energy saving priority as well. A characteristic of this task is that energy saving practices in electrical end uses normally do not affect the indoor comfort. The general good practices to save energy optimizing electrical demand are summarized in the Deliverable. Here follow a list of possible interventions: ➢ to maximize the use of natural light in indoor spaces, ➢ to install light-emitting diodes (LEDs) everywhere it is allowed, ➢ to eliminate incandescent lamps, ➢ to replace older T12 or T8 technologies with Super T8 lamps and high-efficiency electronic ballasts, ➢ to incorporate day lighting controls in patient rooms and public spaces with large window areas, ➢ to integrate controls that enable continuous dimming (100 to 5 percent lamp power), ➢ to install occupancy sensors in spaces that are frequently unoccupied, such as restrooms, stairwells, service areas, and mechanical plants, ➢ to use sensors that include dimming and stepping options for spaces that utilize day lighting, ➢ to incorporate exterior motion sensors, which save energy and can enhance security Regarding the methodology, the technologies of the sector are then searched, selected and briefly described in Appendix 1 of the Deliverable 2.1, grouping them in accordance to their position in the energy supply chain. From the list it is clear that not all of them are Electrical systems. In the list that follows only the last have been selected. ➢ Energy distribution technologies (i.e. Light management system): ➢ Energy delivery technologies(i.e. Lighting type, Motors, Electric heating; Electric floor heating,), ➢ Energy storage technologies (i.e. Batteries); ➢ Supporting technologies (i.e. Emergency Power System, DC grid, Smart grid)
Relationship to STREAMER	Electrical end uses in hospitals are always considerable. The acknowledgement of their size and dynamics is fundamental to weight the effectiveness of the several energy policies that can be developed. In particular plants fed by renewables have the largest potential in terms of primary energy and carbon emissions reductions since they replace consumptions based on a fossil fuel supply chain with green and clean technologies. This is exactly what of STREAMER fundamental expectation.
Additional comments	None
WP7 partner	BEQ/AOC

4.3.3 Plumbing systems

TITLE	Plumbing systems - current practices: Water supply systems
Reference	STREAMER Deliverable 2.1 http://project.demobv.nl/STREAMER/Shared%20Documents/Forms/AllItems.aspx?RootFolder=%2fSTREAMER%2fShared%20Documents%2f08%20WP2%2fDeliverable%202.1%20-%20review&FolderCTID=0x0120002E82D5CE50A8CC4589162F983428E5E1&SortField=Modified&SortDir=Asc&View={D47F4D17-40F2-4354-BE4B-A21F317014FC}
Status	Not applicable

Language	Not applicable
Outline	Not applicable
Relevance	Even though plumbing devices are responsible of moderate consumption if compared to the overall hospitals demand, since their high numbers they represent an important item that needs to be carefully considered.
Summary	The current practices in plumbing systems are listed and described in the STREAMER Deliverable 2.1 as well. Energy reduction in this field of operation can be achieved by improving the sanitary system at the first step. This is possible through several actions, listed in the Deliverable: ➢ By reducing the consumption of water by upgrading toilets and lowering the leakages, ➢ Equip showers and taps with low-flow faucets and use of more efficient washing machines, ➢ In general achievement of maximal efficiency of water production and distribution. ➢ Pursue piping insulation thickness. ➢ To achieve circulation system effectiveness. ➢ To achieve pumping system effectiveness. ➢ To investigate storage possibilities with introduction of buffer tank loading schedule. ➢ To seek the reuse of grey water. ➢ To use of rain water for flushing the toilets. Regarding the methodology, plumbing technologies are then searched, selected and briefly described in Appendix 1 of the Deliverable, grouping them in accordance to their position in the energy supply chain. From the list it is clear that not all of them are plumbing devices. In the list that follows only the last have been selected. ➢ Energy distribution technologies (i.e. Sewage heat recovery): ➢ Energy delivery technologies(i.e. Water tap), ➢ Energy storage technologies (i.e. Local buffer tank for DHW, Small Aquifer Thermal Energy Storage and Borehole Thermal Energy Storage); ➢ Supporting technologies (i.e. Chemical disinfection of domestic hot water).
Relationship to STREAMER	The expected general increase in plant efficiency cannot exclude plumbing and water supply systems, even though their optimization seldom allow a significant reduction in primary energy consumptions.
Additional comments	None
WP7 partner	BEQ/AOC

4.3.4 Supporting technologies

TITLE	**Supporting technologies - current practices:** **Building control system** **Medical gasses** **Steam production**
Reference	STREAMER Deliverable 2.1 http://project.demobv.nl/STREAMER/Shared%20Documents/Forms/AllItems.aspx?RootFolder=%2fSTREAMER%2fShared%20Documents%2f08%20WP2%2fDeliverable%202.1%20-%20review&FolderCTID=0x0120002E82D5CE50A8CC4589162F983428E5E1&SortField=Modified&SortDir=Asc&View={D47F4D17-40F2-4354-BE4B-A21F317014FC}

Status	Not applicable
Language	Not applicable
Outline	Not applicable
Relevance	The item is fundamental since it is pivotal and coherent to one of the main scope of STREAMER (*i.e.* the optimization of the energy performance of the healthcare facilities through Semantics-driven Design methodologies with interoperable tools for Geo and Building Information Modelling - Semantic BIM and GIS). The potential of energy savings from the application of god practices (BIM and BMS for instance) in this field is outstanding since the possibility of zeroing all the wasted related to bad management habits. This is true for the Italian scenarios as well.
Summary	The practices in this field are listed and described in the STREAMER Deliverable 2.1. The main items of the categories are represented by BIM and BMS systems, and by other supporting technologies, characteristic of hospitals, like medical gases devices and steam production. All of them are well and widely described in the Deliverable 2.1 providing data that well match with the Italian case studies as well. Again the summary in the Appendix 1 of D 2.1 lists a lot of these systems, grouping them in accordance to their position in the energy supply chain. ➢ Energy distribution technologies (i.e. Light management system, BMS system and BEMS system, Regulation), ➢ Supporting technologies (i.e. Chemical disinfection of domestic hot water, Smart grid)
Relationship to STREAMER	Building control systems are fully compliant to BIM approach and hence represent a key and basic feature in STREAMER. The control of indoor air temperature and humidity in fact is the most effective action that can be put in force to obtain the desired 50% reduction of the energy requirements and carbon emission cutting all the wastefulness.
Additional comments	None
WP7 partner	BEQ/AOC

4.3.5 Envelop

TITLE	Envelope - current practices: Vertical envelope; Horizontal envelope
Reference	STREAMER Deliverable 2.4 http://project.demobv.nl/STREAMER/Shared%20Documents/01%20Deliverables%20final/D2.4%20STREAMER%20-%20EeB%20technologies%20for%20building%20envelope%20and%20space%20of%20healthcare%20buildings%20FINAL.pdf
Status	Not applicable
Language	Not applicable
Outline	Not applicable
Relevance	In Italy, as in the other European Countries, the envelope of Healthcare buildings is considered one of the most important element to be deal with in terms of energy efficiency.
Summary	The European current practices applied to reduce the energy consumption in healthcare buildings are listed and described in the STREAMER Deliverable 2.4. The Deliverable deals with the State-of-the-art review of architectural solutions (i.e. building envelope and spatial design) for energy-efficient healthcare buildings. The Deliverable focuses on the identification of technologies and environmental design criteria that are feasible to implement and to benchmark necessary energy performance standards for energy savings in healthcare districts. The data collected show the updated State of the Art of the EeB solutions for building envelope (both façades and top closures): each chapter identifies strategies and opportunities for a significant energy reduction considering technical - related to the envelope issues. The choice has been made considering the suitability of a specific technology in healthcare buildings. The focus is both on new construction and retrofit actions: recommendations may be applicable to hospitals undergoing complete renovation, partial renovation, addition, remodelling, and modernization projects. Regarding the methodology, the EeB technologies for building envelope in hospitals were searched, selected and briefly described. The resulting preliminary list of the state of the art of technologies was then reviewed and a selection of the most appropriate technologies was done and described more in detail. Finally, the technical numerical parameters describing each solution was collected, listed and described in a table. In Italy, according to the classification shown in the report, the current practices applied in healthcare facilities are as follows. **VERTICAL ENVELOPE (FAÇADES)** ETICS - Traditional and light colour of outside wall: Well-known and applied. ETICS - Transparent Insulation Materials (TIM): Polycarbonate insulation material is not convenient in Mediterranean Countries. Highly insulated windows with aerogel sometimes are used in retrofitting project. Ventilated façades - Opaque Ventilated façades: Opaque ventilated façades are well known and applied mainly in retrofitting project. Ventilated façades with PCM sometimes are used in retrofitting project. Ventilated façades - Double skin glass façades: Well-known and occasionally applied. Ventilated façades - Hybrid façades (wall/glass): Trombe wall and Hybrid ventilation system are rarely applied. Solar shading – External: Well-known and applied. Solar shading – Internal: Well-known and applied.

	Passive solar energy system - Solar greenhouse: Even if mostly diffused in residential buildings, solar greenhouse and solar wall ® are sometimes applied in healthcare facilities. Solar chimney or ventilation chimneys are not used in healthcare facilities. Green wall are starting to be used (reduction of working energy consumption and quality for the comfort of patients and doctors) Active solar energy system - Photovoltaic panels: Well-known and applied. Active solar energy system - Solar collectors: Well-known and applied. Active solar energy system - Mixed systems: Well-known and applied. High efficiency windows – Double/triple glazing with solar films: Well-known and applied. High efficiency windows – Double/triple with Low – E glass: Well-known and applied. **HORIZONTAL ENVELOPE (TOP CLOSURES)** Pitched roof with discontinuous waterproof surface – Microvented: Less used (generally roofs for hospitals are flat). Pitched roof with discontinuous waterproof surface – Insulated: Less used (generally roofs for hospitals are flat). Pitched roof with discontinuous waterproof surface - Vented (single VL): Less used. Pitched roof with discontinuous waterproof surface – Vented (double VL): Less used (generally roofs for hospitals are flat). Pitched roof with discontinuous waterproof surface – Insulated + vented (single VL): Less used (generally roofs for hospitals are flat). Pitched roof with discontinuous waterproof surface - Insulated + vented (double VL): Less used (generally roofs for hospitals are flat). Pitched roof with continuous waterproof surface – Insulated: Not used. Pitched roof with continuous waterproof surface - Vented (single VL): Less used (generally roofs for hospitals are flat). Pitched roof with continuous waterproof surface - Vented (double VL): Less used (generally roofs for hospitals are flat). Flat roof – Insulated: Well-known and applied. Flat roof - Vented (double roof): Well-known and commonly applied. Flat roof - Insulated + vented: Well-known and commonly applied. Flat roof - Green roof: well-known and occasionally applied. Flat roof - Cool roof: Well-known and commonly applied. Active solar energy system - Photovoltaic panels on top: Well-known and applied. Active solar energy system - Integrated photovoltaic panels: Well-known and applied. Active solar energy system - Photovoltaic panels built in: Well-known and applied. Active solar energy system – Photovoltaic waterproof panels: Sometimes applied in existing pitched roof. Active solar energy system – Solar collectors: Well-known and applied.
Relationship to STREAMER	The State-of-the-art review of architectural solutions related to EeB technologies for building envelope of healthcare buildings is one of the basic reference for the STREAMER project to reach its main aim: the 50% reduction of the energy use and carbon emission of new and retrofitted buildings in healthcare districts by optimising Semantics-driven Design methodologies with interoperable tools for Geo and Building Information Modelling (Semantic BIM and GIS) to validate the energy performance during the design stage. STREAMER will enable designers, contractors, clients and end-users to integrate EeB innovations for: 1) building envelope and space layout; 2) medical, MEP and HVAC systems; 3) Building and neighbourhood energy grids.
Additional comments	None
WP7 partner	IAA/AOC

4.4 Conclusions

To sum up, we can conclude that the Italian government and organisations, especially healthcare districts, are heavily focusing on energy efficiency in their buildings. The laws and regulations we have studied in this section, and the current practices and ongoing work, show the high interest in achieving better energy performance of the buildings and the relevant reduction of carbon emissions. Furthermore, the conferences, current and future projects reveal that these improvements and investments will continue until achieving secure energy supply and lower environmental impacts.

However, the results that STREAMER aims to reach, should provide inputs for valuable change in the energy efficient buildings sphere. Indeed, STREAMER would contribute to improve the State of the Art on different levels.

On the one hand, STREAMER should improve the State of the Art on tool level as it should provide the BIM and ICT software suitable to identify, control and assess all the energy related features during the design or operation phase of a hospital. These tools would operate as an important decision-making tool to evaluate the energy performance in relation to the rules and values set in national laws, guidelines, etc.

On the other hand, STREAMER should improve the State of the Art on design level. Indeed, STREAMER would gather all the expert knowledge and define guidelines, design criteria, approach to typology that could allow stakeholders to apply this knowledge to design energy-efficient healthcare district.

As stated, Italy has largely worked to set the rules and define the objectives regarding energy-efficient building. Not always the EeB rules established are respected or the energy aspects well assessed, either in design and operation phase. This happens often due to lack of resources and tools. This matter still requires to be solved in the current practice of our country. STREAMER could help to solve this problematic issue through the definition of assessment tools that could help the involved actors to easily evaluate the energy related features while designing and monitoring them.

5. Polish section

5.1 Introduction

5.1.1 Background

As energy efficiency and CO_2 emission become very important issues in European Union among EU Members, Poland in answer to this convention has implemented legal tools to achieve the energy efficiency goal. This and need of reducing the expenses forced hospital owners to take some actions which will help them to reduce costs.

Implementation of "pro energy efficiency" programmes in Poland gave the opportunity to increases savings while rebuilding the energy source to highly efficient cogeneration or renewable.
Some Healthcare buildings in Poland were thermo-modernized with support from refunding of credits taken for refurbishment action.

Most of effort taken to improve building energy efficiency is driven by need of reducing the annual costs of maintenance and need of refurbishment old and not effective systems. Another motivator is reduction of primary energy use by the facilities.

5.1.2 Aim

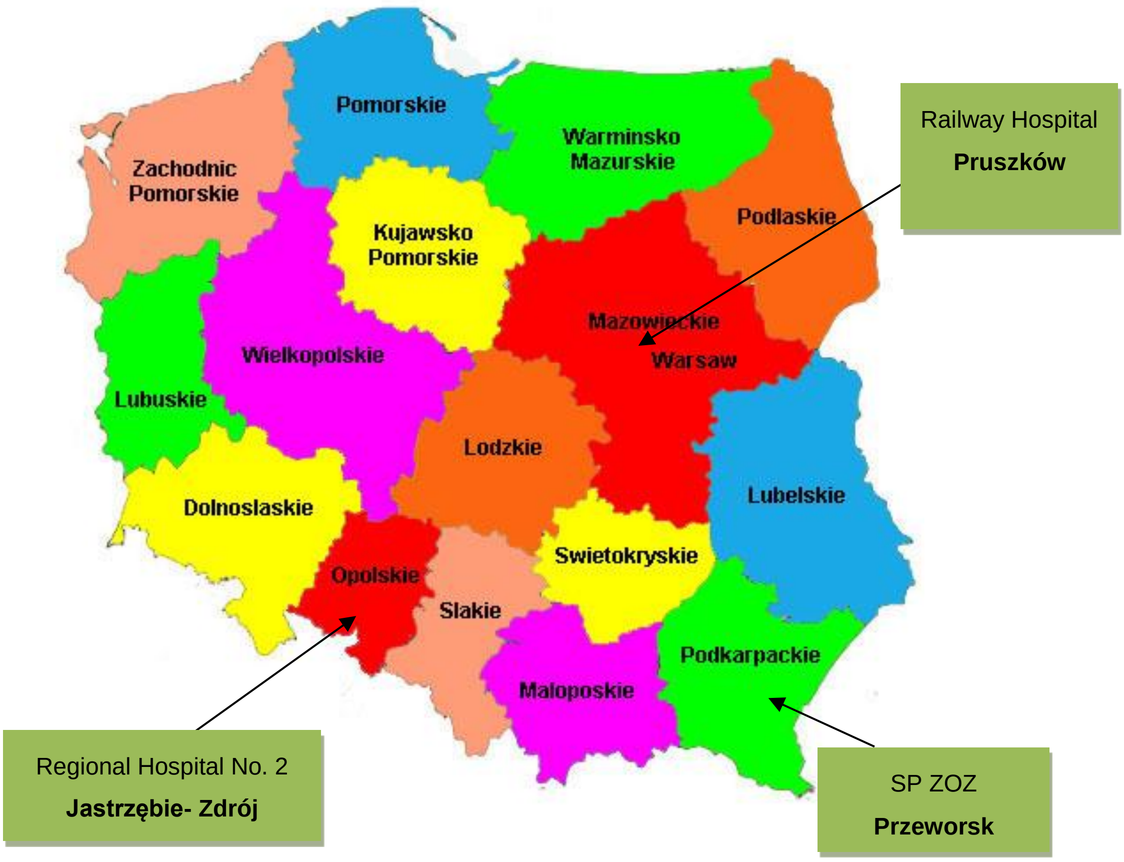
The aim of this work is to provide an overview of Polish hospital projects focused on energy saving and application of new technologies with use of non-renewable energy sources. Examples of how this was realized among the country during recent years are described within this document. Knowledge presented within this document may be later implement to other EU countries.

5.1.3 Method

The purpose of this document is to share knowledge and experience from energy system solutions at healthcare centres in Poland. This is done by describing energy efficient solutions and technologies which find application in Polish hospitals basing on projects developed within the country.

5.1.4 Scope and limitations

Selected examples of hospitals shown on the following map:



5.2 List of Polish Hospitals that have made Energy Efficiency implementation

5.2.1 Complex thermo modernization of hospital SP ZOZ in Przeworsk[1]

Scope: Implementation of the project was aimed at reducing the consumption of thermal energy through thermal modernization walls, roofs, replacement of doors and windows, installation of valves thermostatic and use of solar energy for water heating. The detailed aim was to reduce CO_2 emissions into the atmosphere, which will positively impact on environment protection.

Project size:

Total project costs: 369 734,11euro

Founding: 312 963.37 euro

Retrofitted building volume: 31 344.00 m^3

Heated space volume: 22 123.00 m^3

Number of solar collectors: 80 units (202.4 m^2) situated on field of 1380 m^2

Power of solar plant: 165,2kW with yearly obtained power 90MWh

[1] http://spzoz-przeworsk.home.pl/EU/Termomodernizacja.pdf

Before thermo modernization

After thermo modernization

Solar collectors field

Boiler room

TITLE	Template table for representing the information
Reference	http://spzoz-przeworsk.home.pl/EU/Termomodernizacja.pdf
Status	Public
Language	Polish
Outline	Implementation of the project was aimed at reducing the consumption of thermal energy through thermo modernization walls, roofs, replacement of doors and windows, installation of valves thermostatic and use of solar energy for water heating. The detailed aim was to reduce CO_2 emissions into the atmosphere, which will positively impact on environment protection
Summary	Total project costs: 369 734,11euro Founding: 312 963.37 euro Retrofitted building volume: 31 344.00 m^3 Heated space volume: 22 123.00 m^3 Number of solar collectors: 80 units (202.4 m^2) situated on field of 1380 m^2 Power of solar plant: 165,2kW with yearly obtained power 90MWh
Relationship to STREAMER	Improvement of the energy efficiency
Additional comments	non
WP7 partner	MOW

5.2.2 Railway hospital in Pruszków[2]

Scope: installation of new heating station with use of heat pumps, solar collectors and cogeneration. Heat is used for domestic hot water preparation and space heating.

Size of investment:

- New central heating pipes and 483 pieces of radiators
- The solar installation of 173m^2 heat exchange surface of flat plate collectors with two substations for hot water.
- Cogeneration module of thermal power 115kW and 70kW of electrical power.
- Gas system with pressure reduction and metering station and a gas boiler with a capacity of 270kW.
- Heat pumps using geothermal energy located in five substations, with the lower source in the form of 98 boreholes of 100 meters each.

Boiler room

Solar coletors on the roof of hospital building

TITLE	Railway hospital in Pruszków
Reference	http://mws.org.pl/artykul,termomodernizacja-szpitala-kolejowego-w-pruszkowie,124
Status	Public
Language	Polish
Outline	Installation of new heating station with use of heat pumps, solar collectors and cogeneration. Heat is used for domestic hot water preparation and space heating
Summary	In the hospital it was installed: • New central heating pipes and 483 pieces of radiators • The solar installation of 173m^2 heat exchange surface of flat plate collectors with two substations for hot water. • Cogeneration module of thermal power 115kW and 70kW of electrical

[2] http://mws.org.pl/artykul,termomodernizacja-szpitala-kolejowego-w-pruszkowie,124

	power. • Gas system with pressure reduction and metering station and a gas boiler with a capacity of 270kW. • Heat pumps using geothermal energy located in five substations, with the lower source in the form of 98 boreholes of 100 meters each.
Relationship to STREAMER	Improvement of the energy efficiency
Additional comments	non
WP7 partner	MOW

5.2.3 Comprehensive thermal Regional Hospital No. 2 in Jastrzębie-Zdroj, including replacement of the heat source[3]

Scope: Aim of investment was to reduce the energy use by hospital complex. After completing the project the average fuel investments decreased from 14 865 to 10 576 GJ. Therefore decreased by an average of 4 292 GJ which is about 30%.

Size of investment:

- Exchange of heat source - in place of the thermal energy from district heating - heat pumps are used. Unit's power is 716 KW and lower source is realized in the form of vertical geothermal probes with a depth of 150 m each. A total of 102 boreholes made with a length of 15 300 m.
- Installation of 225 solar collectors with a total area of 410 m^2.
- Modernization of Central Heating system:
  - Hotel: replacement of vertical and horizontal, refurbishment of 746 heating radiators
  - Office and Laboratory: replacement of vertical and horizontal pipelines, installation of over 501 central heating radiators and thermostatic radiator valves.
- Modernization of mechanical ventilation in Office, Laboratory and the kitchen.
- Modernization of the heat exchangers.
- ETICS installation with window replacement.

Before thermal modernization

After thermal modernization

[3] http://www.wss2.pl/index.php?option=com_content&task=view&id=259&Itemid=31

TITLE	Regional Hospital No. 2 in Jastrzębie - Zdroj
Reference	http://www.wss2.pl/index.php?option=com_content&task=view&id=259&Itemid=31
Status	Public
Language	Polish
Outline	*Aim of investment was to reduce the energy use by hospital complex.. After completing the project the average fuel investments decreased from 14 865 to 10 576 GJ. Therefore decreased by an average of 4 292 GJ which is about 30%.*
Summary	In the hospital it was installed: • Exchange of heat source - in place of the thermal energy from district heating - heat pumps are used. Units power is 716 KW and lower source is realized in the form of vertical geothermal probes with a depth of 150 m each. A total of 102 boreholes made with a length of 15 300 m. • Installation of 225 solar collectors with a total area of 410 m^2. • Modernization of Central Heating system: • Hotel: replacement of vertical and horizontal, refurbishment of 746 heating radiators • Office and Laboratory: replacement of vertical and horizontal pipelines, installation of over 501 central heating radiators and thermostatic radiator valves. • Modernization of mechanical ventilation in Office, Laboratory and the kitchen. • Modernization of the heat exchangers. • ETICS installation with window replacement.
Relationship to STREAMER	Improvement of the energy efficiency and building thermal modernization action.
Additional comments	non
WP7 partner	MOW

5.3 Energy Efficiency potential in polish hospitals

5.3.1 Analysis of current status of energy use and energy supply mix

Polish structure of electrical energy production is based on coal, 55.6% of power plants are charged by bituminous coal, 36.9% of power plants are charged by brown coal. Basing on data from 2011 renewable energy sources is acknowledged for 1.75% of all power plants in Poland. Percentage of the national electricity production of particular groups of plants by type of fuel in 2011 is presented in the Figure 1.

However, amount of energy from renewable in obtaining total primary energy for Poland is constantly increasing what is shown on diagram in Figure 2.

Figure 3 presents the share of renewable energy in the total obtaining energy from renewable sources in the year 2011. The overwhelming amount of energy is obtained from solid biomass which is burned in power plants boilers.

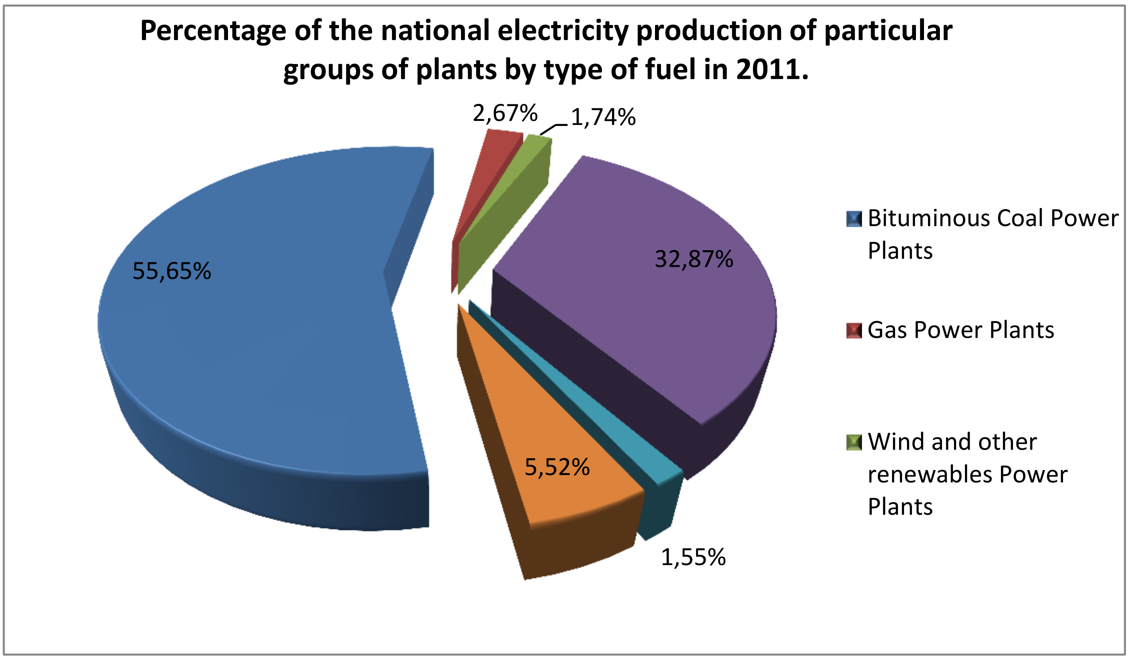


Figure 1 Percentage of the national electricity production of particular groups of plants by type of fuel in 2011.

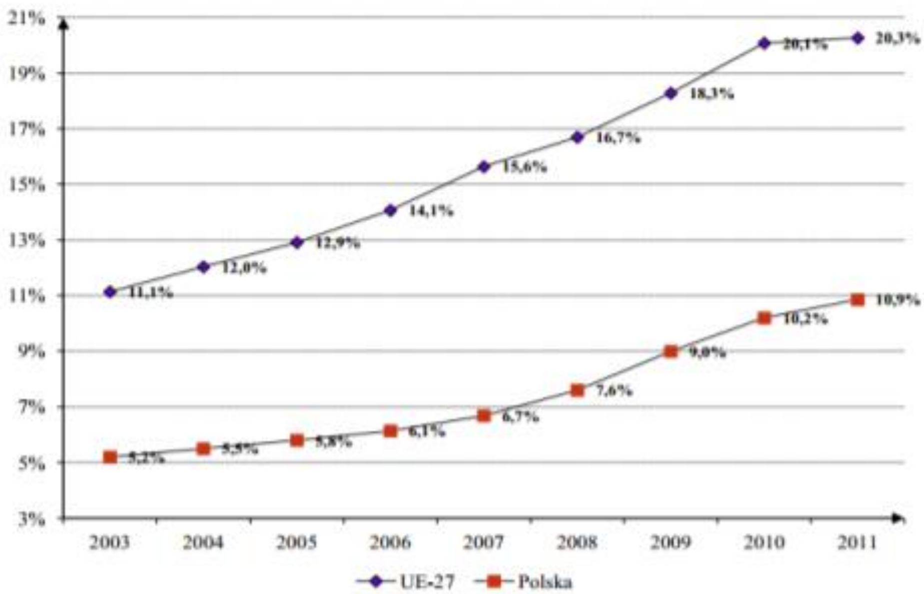


Figure 2 Amount of energy from renewable in obtaining total primary energy for Poland (red squares) and in UE (blue squares) 2003-2011.
Source: Central Statistical Office of Poland

5.3.2 Building Optimization

Building optimization has high potential especially while building new health care facilities. In already existing buildings changing the function of certain space can be expensive and non-effective.

5.3.3 Voltage Optimization (VO)

The main voltage supplied by the network should be 230V and in practice varies between ± 10%. The voltage level depends on the demand for electricity, the quality of the electrical infrastructure and the distance from the main transformer. The voltage fluctuations, especially overvoltage, have a negative impact on electrical and electronic equipment, lighting and other infrastructure. The high voltage reduces the effectiveness of the use of equipment, increases losses and waste of energy. The voltage optimization minimizes equipment failures and extends their lifespan. An operation of electrical equipment on reduced and stabilized voltage generates 18% energy savings (http://www.psepolska.pl/). Moreover, reduces losses in the network and minimizes the reactive energy. The voltage reduction is intended to improve the efficiency of the device with AC motors, such as: air conditioners, compressors and pumps. The reducer reduces power consumption and improves the power factor.

5.3.4 Lighting

At present, most of the light is delivered by fluorescent light bulbs and in many cases the old type light bulbs, therefore there is an energy saving potential in lighting. It can be realized by installing more efficient light bulbs and also by occupancy sensors and replacing old inefficient fixtures. It is also good to make people aware of their contribution in energy savings by reminding them (small leaflets and signs) to turn off the lights when not occupy the rooms. When it comes to newly design buildings it is important to take into account possibility of using the natural day light especially in corridors and internal space. To make hospital district more energy efficient LED and solar street lights can be installed.

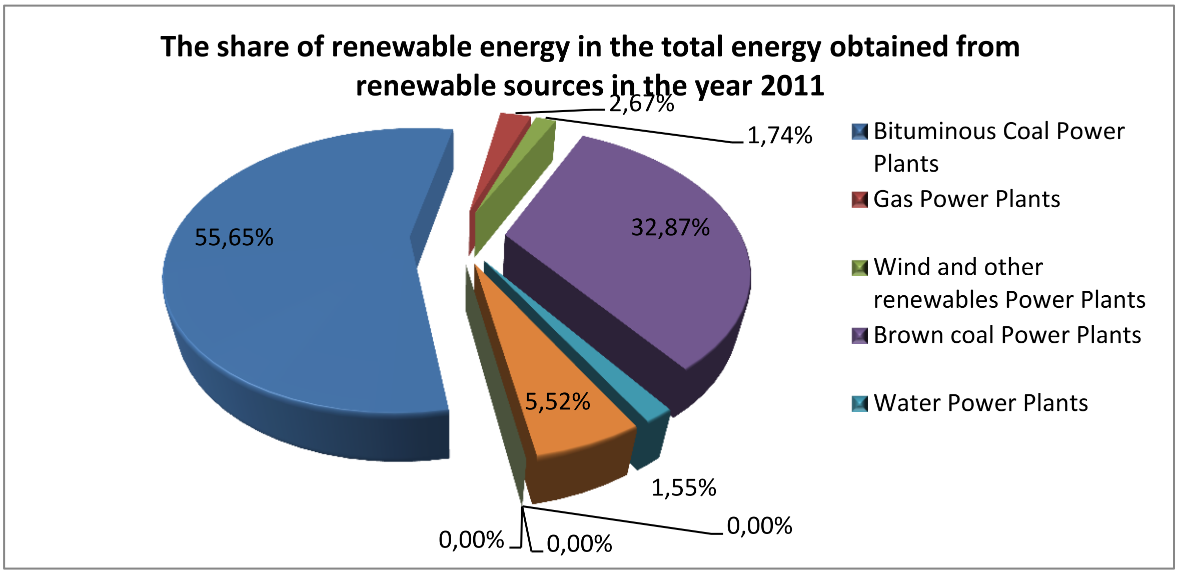


Figure 3 the share of renewable energy in the total energy obtained from renewable sources in the year 2011. Source: Central Statistical Office of Poland

5.3.5 Heating

In Polish climate heating season lasts from September till May. The most common systems are water, high parametric (e.g.90/70oC) installations with radiators. If well sized and controlled systems are efficient but in many cases temperature regulation is hard to realise and spaces are overheated this results people open the windows and energy is lost. Problem can be solved by installing thermal regulation valves. After that hydraulic regulation of heating installation is essential. Typically heat sources are gas boilers or district heating and local coal based boilers, second option is more common in big cities where there is possibility of connection to the heating network. In new build facilities floor heating can be designed and renewable energy sources such as heating pumps can be used.

5.3.6 Cooling

In Polish climate demand for cooling is rather small comparing to Mediterranean climate. However to increase comfort during the summer cooling system is also installed in the hospital facilities. Standard solutions are fan coils powered by chilled water prepared in compressors. Sometimes wall mounted split units are installed. There is a possibility to use solar energy to produce chilled water, free cooling is also possible.

5.3.7 Heat Pumps

Heat pumps are installed in hospital buildings. There are heat pumps with ground low thermal heat source, exhaust air heat pumps, air heat pumps and water heat pumps installed. Most of actions taken in this field are co-financed from European Union programs and Regional Programs like LEMUR- Energy efficient Public Building financed by National Found of Environmental Protection and Water Management.

5.3.8 Energy Efficient Equipment

Attention should be put while choosing kitchen equipment, refrigerators and sterilizations units as they may consume big amounts of energy. It is good to look for low energy equipment which can be found on the market like refrigerators with energy class A++ or A+++.

5.3.9 Variable Speed Drives (VSD)

Variable speed drives according to new building regulation in Poland are obligatory and have to be mounted in new build facilities. It is now a common practice to replace standard drives with VDS.

5.3.10 Under floor heating

This technology should find usage in health care facilities as it has a lot of advantageous and cooperates smoothly with renewable, low temperature sources. It also allows for keeping the floor clean and easy to maintain hygienic conditions. However in most of Polish health care facilities conventional, wall mounted heaters are used and usually work on high parameters.

5.3.11 Building Envelope

In order to improve building energy efficiency many of facilities has their envelopes insulated with ETICs. This technology is the most common way of improving building thermal insulation in Poland.

5.3.12 Combined Heat & Power (CHP)

As hospitals need both electrical energy and heat all year long there is a high potential of installing CHP units. There are hospitals in Poland which plan or already invested in combined heat and power as well as in tri-generation.

5.3.13 Renewable Technology

Renewable technologies, especially solar collectors at the roof of hospitals are very popular in Poland. Geothermal has lower potential and local wind energy production for the purpose of hospital is hardly ever used.

5.3.14 Biomass

Biomass is an ecological fuel and can by burn in boilers with very low carbon print. This technology finds application in health care facilities which have solid fuel boilers.

5.4 The Vision/The process

Nowadays, In Poland a lot of action has been taken to decrease the usage of primary energy and minimize the carbon foot print. To achieve the goals of the European Union regulations, Polish law is changing, setting up the direction towards decreasing the fossil fuels usage and CO_2 emission. All buildings have to have Energy Efficiency Certificate and fulfil the requirements stated in Building Law. There were following documents created to meet the European energy efficiency strategy.

In recent years, the energy intensity has dropped by 30%, mainly by thermo-modernization project. The public sector, including hospitals is one of the priorities to implement the energy efficiency measures. The integral part of the energy efficiency system is Poland is White Certificates schemes. Program aim is to support investors to build renewable energy sources and high efficient cognation. For every kWh of “green energy” producer gets the certificate which can be sold on the market.

5.4.1 Long and short term goals

Improving energy efficiency, development of renewable sources of energy and reducing the impact of energy on the environment are the main goals. The scenarios and actions taken should lead to the fact that the share of renewables in total primary energy consumption will increase from approx. 5% (2006), 12% in 2020, and 12.4% in 2030.

5.5 Conclusions

To sum up, there are various actions taken in Poland to improve energy efficiency not only in health care but in the whole buildings and public sector. Present law and regulations lead to wiser and more reasonable way of buildings design and maintenance. People became more and more aware about environmental issues. Many renewable installations were built during the past years and are there are investments made all the time.
Pro-renewable policy affects the legal provisions which results in the introduction of many facilitations for investors wanting to invest their money in renewable energy sources.

Tools developed in Streamer project will simplify the decision making process by fast and easy way of making the comparison between several energy efficient options and help to implement BIM as an easy and reasonable way of facility management.

6. Swedish Section

6.1 Introduction

The aim of this section is to share knowledge and experience from hospital projects in Sweden. This is done by describing the legislation, the historical development and the different organisations for reducing the energy use in Swedish hospitals. Moreover, the energy goals, the process and the technical solutions to reach more strict energy requirements in different parts of the country are presented. Finally, the experience from different Swedish hospital projects and the potential of implementing similar energy solutions in other EU countries are discussed.

6.2 List of Swedish Hospitals that have made Energy Efficiency implementation

In this section, the targets set up by the county councils are presented followed by a description of the work to achieve these goals by the main actors in each county. Examples of implemented measures and energy savings achieved are presented for one hospital in each county.

In Sweden, there are nine regional hospitals and around 70 local hospitals in the counties. This section only covers three out of twenty Swedish counties: the Stockholm County, the Västra Götaland County and the Västernorrland County, all with high ambitions with regards to energy efficiency measures. For each region, one hospital project is described in detail, see Figure 4.

Figure 4 Counties and hospitals described in this section.

6.2.1 Stockholm County

6.2.1.1 Regional targets

In Stockholm County, five regional goals are presented in their strategy (TMR, 2010):

1. The county's greenhouse gas emissions outside emissions trading reduced by 19 % by 2020 compared with 2005. Activities that are regulated of the emissions trading while its emissions are cut by 80 % to 2050.
2. The region's energy use is 20 % more efficient in 2020 than in 2008, measured in energy intensity (thermal energy per unit of GDP in constant prices).
3. The climate changing emissions energy gives rise to decreases by 20 % per capita 2020 (tonnes of CO2 equivalent) compared 2005 and by 40 % to 2030.
4. By 2020, 16 % of energy transport is renewable.
5. Energy production in the county takes place in 2020 to 90 % with renewable fuels, whereas peak production in 2030 takes it to 100 % by renewable fuels.

6.2.1.2 Locum's work to save energy

Locum has a portfolio of approximately 2.1 million square meters of premise in the Stockholm region, and thereby, is one of Sweden's largest property owners. There are two university hospitals in the Stockholm County: Karolinska University Hospital in Solna and Karolinska University Hospital in Huddinge. There are four emergency departments: Sankt Göran, Söder, Södertälje and Danderyd hospitals. Other hospitals are various kinds of medical centres.

Locum applies a holistic approach to energy efficiency measures. 1996 Locum changed their heat supply from local plants to district heating which improved the environmental performance of the buildings considerably. Locum has also managed to decrease their energy use between the years 1995 and 2003 by 27 kWh/m2 (50 GWh in total). Locum was a major participant in a project that was called the Negawatt project. The project lead to a labelling of all of their buildings according to their energy use and to the measures implemented at each building.

Locum has worked with measuring and mapping of energy use (heat, cold, electricity, steam, compressed air) in all their buildings for many years. The hospitals and their energy use (electricity, space heating and hot water) in the year 2013 are presented in Figure 8. The average annual use of electricity (including electricity for medical services) is almost 100 kWh/m2 and the average energy use for space heating and hot water is 110 kWh/m2, year. There are large differences in energy use among the hospitals which depend on different age of the buildings, on different technologies applied and on the different activities in the hospital.

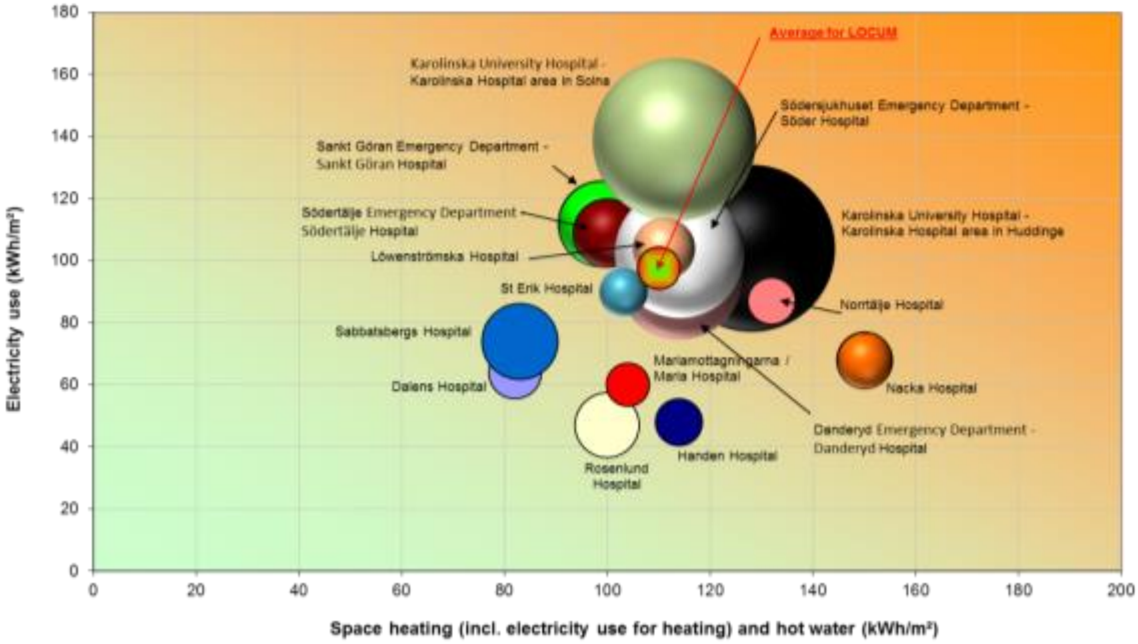


Figure 5 Properties responsible for 95 % of the total energy use in all LOCUM properties in the year 2013 (LOCUM, 2014). The size of the circles represents the size of the hospital (in m^2).

6.2.1.3 Example of measures and energy savings at Karolinska University Hospital

In this section, the energy saving measures at the Karolinska University Hospital in Huddinge, see Figure 9, are described in detail based on Nutsos (2009). Locum has used a similar approach for energy saving measures for all their hospitals and therefore the general methods and conclusions are representative also for their other hospital buildings. The measures described can be applied to other Swedish hospitals, and very easily to similar hospital buildings (built as annex hospitals).

Figure 6 Karolinska University Hospital in Huddinge, Stockholm (source: LOCUM).

<u>General facts about Karolinska University Hospital in Huddinge, Stockholm</u>

- Type of hospital: University hospital
- Building area: 431 000 m^2
- Year of construction: 1968-1972

- Heating system: Hot water radiators
- HVAC: Air conditioning with heat exchange between indoor air and fresh air
- Cooling: District cooling

Initially high energy use for ventilation

Huddinge hospital was planned at the end of 1960. The installation was planned under construction. It resulted in a system with many fans. The ventilation system was made of 12 blocks where each block had two equal size main fan units with bi-motor drive. They pressed air in a pressure chamber that supported 70 secondary fan units that also had bi-motordrive. All of these required many silencers. This led to a system with very high pressure drop, with a high energy use as consequence.

Measures implemented

The Karolinska University Hospital in Huddinge was built in early 70's with a multi-fan ventilation system. Until mid-80's, the total airflow was very high. Since then the ventilation system has thoroughly been inspected and modified from a high pressure system to a lower pressure. The first step was to change the flow and adjust the system to the operating hours. Secondary fans overloading the system were removed. The main fan units were outfitted with flat belts instead of cogged belts. Afterwards, due to considerable leakage flow, dampers were changed. The system was adjusted further. Airflow resistance through the devices and ducts was reduced and the amount of air transported was dropped. Lower flow and pressure caused the system to function quietly. Silencers were removed and duct locations were also improved. It meant less pressure drop and the system became more efficient. During summertime the need for cooling reduced since outdoor airflow was reduced.

Energy savings achieved

Table 1 shows the different measurements implemented and the savings achieved. The total savings in electricity amounts to 5.6 million kWh/year and the heat energy to nearly 30 million kWh/year! The reduction of air flow also involves less air flow that has to be cooled, about 129 000 kWh/year, which saves even more electricity.

The measures that have been applied to Huddinge annex hospital should be possible to easily copy to all other so-called annex hospitals and to other hospitals as well, with large energy saving potential. For instance, the same measures have been implemented at Handens hospital (in Stockholm County) with great energy savings as consequence. Possibly, all other hospitals around the country have similar potential for energy savings. This means not only saving energy but also a better indoor environment and more quiet systems.

Table 1 Energy savings by measures implemented at Karolinska University Hospital in Huddinge. Note that savings related to the surface is based on building area and not heated/cooled area, which is normally used when presenting energy use and savings.

Measures	Savings [kWh/year]	Savings [kWh/m2, year]
All pads are removed and are replaced by adjustable damper (1981)	1 677 200 kWh/year el	2.9

Lower air flow night time (1986)	2 238 200 kWh/year el 26 245 000 kWh/year heat	3.8 44.9
Disassembling secondary fans (1990)	1 147 700 kWh/year el	2.0
Disassembling of LD, improved ducts, flat belt and vanes (1994)	401 000 kWh/year el	0.7
Reduced air flow and lowered operating pressure (1994-1996)	151 000 kWh/year el 2 894 000 kWh/year heat 129 000 kWh/year cooling	0.3 4.9 0.2
Electricity savings by reducing pressure in inlet air chamber and by tightening dampers (1995-1996)	20 500 kWh/year el	0.0
	349 579 kWh/year heat	0.6
Total savings	**5 635 600 kWh/year el**	9.6
	29 488 570 kWh/year heat	50.4
	129 000 kWh/year cooling	0.2

6.2.2 Västra Götaland County

6.2.2.1 Regional targets

In southwest of Sweden, the Västra Götaland County has a goal of being independent of fossil fuels by 2030. Moreover, there is a target to reduce the energy use in its own facilities by 50% by 2030 (compared to 1995 levels). The rented premises should also be considerably more efficient by 2030.

The target by 2030 is 137 kWh/m^2, year. There is also a part goal of 180kWh/m^2 per year by 2013. Figure 7 presents the historical trend of the energy use in the county's premises. In the year 2012, the energy use was almost 200 kWh/m^2, year. In order to achieve the targets, all new hospital buildings must have a maximum energy performance of 60kWh/m^2 per year (incl. user electricity). When renovating the existing building stock, the energy use must be reduced by 25%. This can be compared to old hospitals in need of renovation which may have an energy use of approx. 300 kWh/m^2, year.

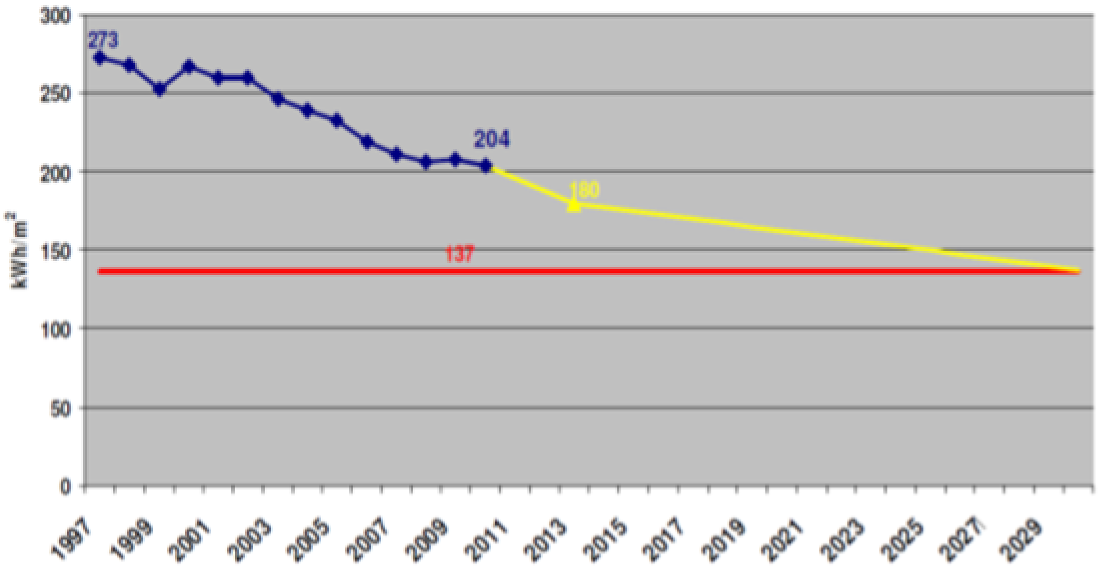


Figure 7 Energy use (space heating, hot water, building electricity, excl. user electricity) in Västra Götaland County's own premises. Blue line represents historical energy use, red line represent the target for 2030 and the yellow line represent the way to reach the goal by 2030 and by 2013 (Lagerkvist and Walter, 2012).

6.2.2.2 Västfastigheter's work to save energy

"Västfastigheter" is the organisation managing the hospital buildings in west Sweden (the region Västra Götaland). Västfastigheter has a portfolio of approximately 1.6 million squaremeters of premises, mainly hospitals. Västfastigheter states that working with small measures that are profitable in accordance with accepted profitability criteria could damage the optimal implementation in the longer term. The policy packages should be maximized in each case in order to achieve the lowest total cost to reach the goal (i.e. even unprofitable operations). This means implementing radical efficiency measures that are cheapest per kWh based on the construction of new buildings, in conjunction with major alterations and then completing a package of measuring in existing buildings.

In Västra Götaland's environmental policy programs for the period 2011 - 2013 there has been an interim target for 2013 of 180 kWh/sqm. This target should not mean that only measures or smaller package of measures being implemented to achieve this target without stimulus packages implemented with the long term goal by 2030. The interim target for 2013 may just be seen as an expression of the rate Västfastigheter have to move in order to reach the long-term goal. In addition, the sooner measures to achieve the target in 2030 are implemented; the more is saved in money, as calculated in terms of reduced energy use.

The strategy for achieving long-term energy goal of a 50% reduction by 2030 can be summarized as follows:

1. Set high standards in new buildings immediately. This will give a large effect in a short time at relatively low cost. A high standard also means a boost to the technique of local renewable energy, such as electricity produced by solar cells.
2. Perform comprehensive energy efficiency measures in connection with the maintenance or reconstruction. Implement radical efficiency measures in conjunction with planned rehabilitation and maintenance operations provides a more cost-effective investment of energy efficiency measures. Energy audit of existing buildings shall precede technically possible actions.
3. Reduce operational energy. Reducing the use of operational energy is achieved partly by direct energy savings but also indirect in the form of reduced energy use of the buildings need air conditioning. Possible measures are partly technical but also behavioural. This requires both technical solutions in order to make it easy to “do right”, but also focus on behaviour of the operational and maintenance staff as well as hospital staff.

For all new buildings, Västfastigheter has to limit the energy use to 60 kWh/m^2, year (including user electricity), as mentioned previously. Nevertheless, this will not be enough to reach the target by 2030. When renovating the existing building stock, the energy use must be reduced by 25 % (Lagerkvist and Walter, 2012). This implies energy targets for existing emergency department hospitals of 164kWh/m^2 per year, for existing local hospitals (närsjukhus) of 135 kWh/m^2, year and 125kWh/m^2, year for other already existing premises.

6.2.2.3 Example of measures and energy savings at Södra Älvsborg Hospital

General facts about Södra Älvsborg Hospital, Borås

The first hospital at Södra Älvsborg Hospital started 1782. Today, the buildings at Borås Hospital corresponds to 200 000 m^2. The T-house, see Figure 8, is a relatively the new care facility at Södra Älvsborg Hospital (SÄS) with a floor area of 20 000 m^2. It was completed in 2010. The T-house building was named after its T-shape, becoming a nursing building where patients have their own rooms with WC. When Västfastigheter built this new care facility, they focused on achieving a good climate shell and modern engineering systems. This included installation of an efficient HVAC system and procurement of energy efficient medical equipment.

Figure 8 T-house at Södra Älvsborg Hospital (photographer: Sten Jansin).

60 % less energy

Initially, the energy target for the building was determined to 100kWh/m^2 (including operational energy use). Thereby, the building will use about 60 % less energy than an average Swedish healthcare facility. It makes the T-house to one of Sweden's most energy-efficient healthcare buildings. All technological solutions have been valued against each other based on a life cycle cost (LCC) to ensure the lowest possible costs when the building is being operated.

Fulfilment of energy requirements

With the help of many people involved in both project planning and the construction stage, the goal was reached. During the construction process Västfastigheter chose to work with NCC Construction in a collaborative form of partnering. The collaboration in the project and NCC's partnering model played an important role to achieve the goals for the T-house.

Building a hospital is complex and therefore partnering cooperation can be a good approach. Partnering is a structured form of cooperation where developers, consultants and contractors jointly solve the task. The method is based on an open and trusting partnership where everyone's skills complement each throughout the construction process.

6.2.3 Västernorrland County

6.2.3.1 Regional targets

The Council of the Västernorrland County has expressed a vision for 2020 that the total energy per unit of area must be halved by 2020 compared with 1995 and that the share of renewable electricity will increase to at least 25 % of total electricity use during the same time period (Landstinget Västernorrland, 2010).

1. Total electricity use will decrease by 10 % compared to 2009, equivalent to 5 GWh, providing a use for a maximum of 84 kWh/m^2 usable area.
2. Total heat use will be reduced by 20 % compared to 2009, equivalent to 12 GWh, which provides a use of a maximum of 95 kWh/ m^2 usable area.

3. The share of renewable electricity has increased to 5000 MWh/year or 10 % of total electricity use by investing in wind and solar power generation.
4. Electricity use for IT related equipment has dropped by 25 % compared with 2010.
5. Total water use to be reduced by 15 % compared with 2009, which provides a use of a maximum of 440 litre/ m^2 usable area.

These long-term objectives were created at a time when electricity use increased at the same time as energy costs increased (Landstinget Västernorrland, 2010).

6.2.3.2 Landstingsfastigheter's work to save energy

Landstingsfastigheter in Västernorrland operates the county's four hospitals and their own premises, corresponding to 500 000 m^2. The objectives presented previously will be achieved by:

- Setting high standards of good energy in new construction and retrofitting
- Operational optimisation of existing building installations
- Invest in targeted strategic energy action
- Energy-efficient choices made in purchasing and procurement
- Investment in renewable energy is implemented

Landstingsfastigheter have worked consequently to reduce the energy use in four hospitals, and especially of the electricity use. The strategy to meet the goal to reduce energy consumption by at least 50 % until 2020 was named Energy Factor 2. The strategy is that every action regarding lighting and HVAC will be implemented if it is sustainable and reduces energy consumption by at least 50 %. Furthermore, they have decided that the best and most effective technology should be used. So far, the energy saving project has led to reduced electricity use by 30 % (Löfvendahl, Anders, 2013). According to Landstingsfastigheter, the investment costs for new lighting technology, ventilation and cooling totals 10 M€ (including financial support), resulting in a savings of 3 M€/year. This money can instead be used for care services.

Landstingsfastigheter has also been an innovative player when it comes to implementing renewable technology and utilising local energy sources. Very early, they invested in photovoltaics and solar thermal collectors. Later, they have invested in photovoltaics which also work as solar shading and in a new solar energy system that produces electricity, heating and cooling simultaneously. Recently, they have also invested in wind power.
Landstingsfastigheter has also been innovative by utilising local sources for cooling such as cooling from the ground, from a nearby river and even cooling from snow.

The largest energy savings have been made at Sundsvall Hospital, the largest healthcare unit in the Västernorrland County, which is described in more detail in this section. Apart from measures regarding lighting and lighting control, there is also the very innovative cooling system based on snow located at this hospital.

6.2.3.3 Example of measures and energy savings at Sundsvall Hospital

The first hospital in Sundsvall started 1776 but the hospital standing there today started 1975. The buildings at Sundsvall's Hospital are about 200 000 square meters.

Lighting and lighting control and energy savings

First, an inventory of the lighting at Sundsvall Hospital was made, including assessment of operating times, lighting levels and power use per square meter. After the inventory analysis, new fixtures and lighting system were installed. Day- and night-time light control was also installed at each department (so that lighting is used only as much needed). At this hospital, the electricity use for lighting was cut by as much as 67 %. At one of the floors, the energy savings were as much as 90 %, of which exchange of fixture (and less number of luminaires) was responsible for 70 % and light control and presence detection for the remaining 20 % (Löfvendahl, Anders, 2013).

The total investment costs were 0.23 M€ and the annual electricity saving corresponds to 740 MWh/year. Assuming that the electricity price is 0.05 €/kWh, this means savings by 37 000 €/year.

Snow cooling and energy savings

Snow-cooling in Sundsvall is a very good example when it comes to exploiting assets in the nearby and doing so in an environmentally friendly way. A schematic figure of the system is presented in Figure 9. The basic principle is simple and based on that snow stored in the vicinity of the hospital during an insulating layer of wood chips. Melt water is filtered and cold pumped through a heat exchanger to the hospital. After cooling, pumped it now lukewarm melted water back to the layer of snow where it is cooled again. The snow is a combination of natural snow and snow made with snow cannons (Advantage Environment, 2009).

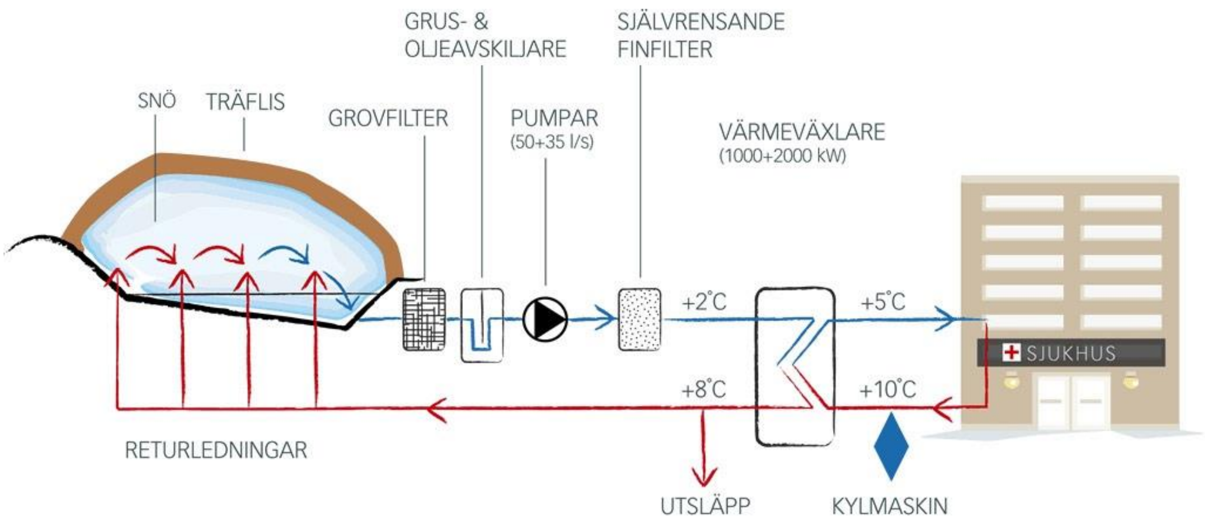


Figure 9 Schematic figure for the snow cooling system at the Sundsvall Hospital (Snowpower, 2014).

Sundsvall Hospital cuts its electricity consumption for cooling from about 900 MWh to approximately 65 MWh per year, which means a reduction by more than 90 %, see Table 2. Another advantage is that no refrigerants are needed and that the snow is cleaned from oil and other waste so it does not end up in nature. The solution is further long-term because the snow cooling plant has a life of 40 years. The plant in Sundsvall show that the technology works and that it is possible to save money by using snow for cooling. You obviously needed electricity to operate the plant, but for roughly 15 times the consumed energy.

Table 2 Results for Sundsvalls Snowpower the years 2000-2005 (Snowpower, 2014)

	2000	2001	2002	2003	2004	2005
Snow [m^3/year]	18 800	27 400	40 700	36 800	35 400	39 900
Share of artificial snow [%]	49	59	57	38	52	70
Snow cooling period	6/6 - 29/8	26/3 - 22/8	25/4 - 29/8	6/5 - 17/8	28/4 - 3/9	22/4 - 19/9
Total cooling produced [MWh/year]	655,5	1159,1	1345,3	1068,4	870,5	941,9
Share of snow cooling [%]	93	77	84	84	92	92
Total cooling capacity [kW]	1366	1648	2004	2034	1919	1995
Snow cooling capacity [kW]	1366	1148	1873	1508	1594	1610
$COP_{snow\ cooling}$	4.3	11.2	17.2	6.2	5.7	6.1
$COP_{snow\ cooling}/COP_{chiller}$	2.0	3.3	6.6	2.6	2.4	3.1

6.3 Current practices for energy efficiency

6.3.1 Guidelines

In In order to make the Swedish hospitals more energy efficient, a lot of work has been undertaken during the last couple of decades. In this chapter, the process from vision to success of implementing energy-efficiency measures in Swedish hospitals is described.

6.3.1.1 Long-term and short-term goals

As mentioned previously, a lot of work has already been undertaken to decrease the energy use in Swedish hospitals, see also the examples in three different Swedish counties presented in Section 1.6. Common for the counties is that they have clearly defined targets to be achieved within a certain time period. In Sweden, the main challenge today is to take steps towards energy-saving decisions that give big energy savings but that might not be "economically" feasible. This requires political courage, as non-profitable energy saving measures will mean less finance to the county councils main focus area: safe and quality-assured healthcare for all citizens.

There are significant challenges in getting politicians, policy makers and technicians to understand each other and work towards the same goal. Politicians and policy makers may set goals without knowing how to achieve them and technicians may design systems that might not help decision-makers to achieve their goals. Therefore, it is important to have long-term politically agreed goals that are accepted and understood by all actors involved: politicians, economists, engineers, building management staff etc. It is also critical that the actors share the views on how energy targets can be achieved in a long-term and a short-term perspective and what actions they have to take in order to reach them. Finally, monitoring of the success rates is very important.

In order to achieve low energy hospitals, it is vital to have knowledge of the process of planning, construction and refurbishment of the hospital buildings, as well as operation and maintenance. Figure 1 describes the building and operation of a hospital as a fragmented process with different actors and split responsibilities. This leads to a risk of lack of communication between both project partners and development phases. This places demands on communication and coordination. It also requires that there is a process that facilitates all actors to work against the same goal and to common understands how to get there.

6.3.1.2 Program for Technical Standard (PTS)

Real estate organisations of county councils in Sweden has developed an IT-based management system for controlling and supporting its building process, regarding energy efficiency, building design and BIM, called Program for Technical Standard (PTS). This IT based system aims to strengthen the client's role through active assumption of responsibility, for acting correctly from start, involving clear instructions, guidelines that set value related goals and good solutions that can be reused (PTS, 2015).

The standard rooms are the good example of solutions in PTS and contain all demands of the room such as interior equipment and functional-requirements together with visualisations of the rooms. The standard rooms are used to make general solutions for wards and clinics. It is valuable for the county council that premises are general and flexible so they can be used for different purposes. The guidelines in PTS set the overall value and demand of standards but the particular requirements are specified in the technical and functional chapter in PTS. Guidelines for each category of clinics such as ventilations flow rates, acoustics, fire preventions, environmental requirements, hygienic and accessibility (disability). In the technical part of PTS there are complementary and clarifying requirements for building regulations and legislation and Sweden's law for health- and medical care.

Each part-owner has one representative person in the board of PTS. The board make the decision of the framework for how and when the IT-system should be updated. For example PTS will be regularly updated after collecting information from the client, contractor, tenants and experience from building projects. Also if the healthcare changes their workflow or a new treatment method, PTS will be updated with new demands and information.

All Real estate organisations of county councils in Sweden aim to lower their costs by acting correctly from start. At the planning-stage many unnecessary issues and investigations are avoided thanks to clear and detailed requirements. By using PTS the real estate organisations will get a more efficient process and customers can decrease their time and participation in the early-stages. This is due to doing right and correct from the start and use proven solutions. It is also easier to involve new participants since the process and the requirements are documented in detail. By using the PTS the real estate organisations of county councils, minimize the errors, since errors are noted, verified and processed in PTS.

6.3.1.3 Public procurement

All public contracts are governed by the Public Procurement Act, This means that, when procure an entrepreneur for development of a new hospital or refurbishment, the county council have to make a specification that all entrepreneurs can make an offer based on the specification. The specification must state how they will evaluate the tenders. Not knowing how to procure qualities such as energy efficient experience, there have been problems in the past when the county council have had to choose the cheapest tender.

Within the Public Procurement Act there are a number of opportunities to make successive and innovative procurements. Swedish public managers need to learn more about alternative procurement and tender evaluation based on parameters other than the lowest bidder, in order to really make a good brief and then evaluate the bids for the best offer. New contract forms are relevant where, for example partnering with mutual incentives and shared risks. For example, Västfastigheter has started to work with innovative-friendly procurement in order to reach their energy-efficiency goals, see Figure 2.

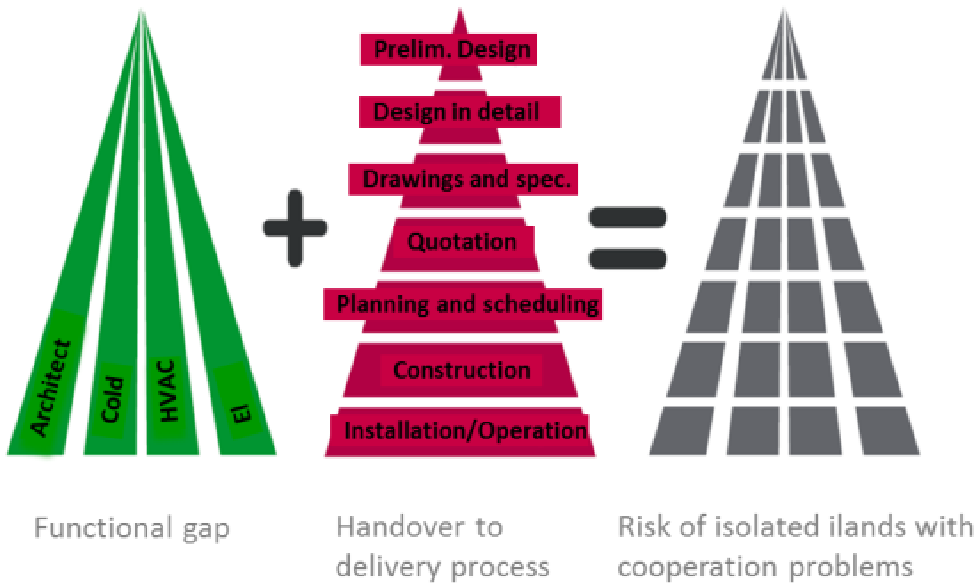


Figure 10 Risk of coordination problems (Green pyramid: Functional gaps. Claret pyramid; Deliveries in the production process. Grey pyramid: Risks for isolated information islands with coordination problems) (Source: Original figure by Mattias Fredriksson, Schneider Electric).

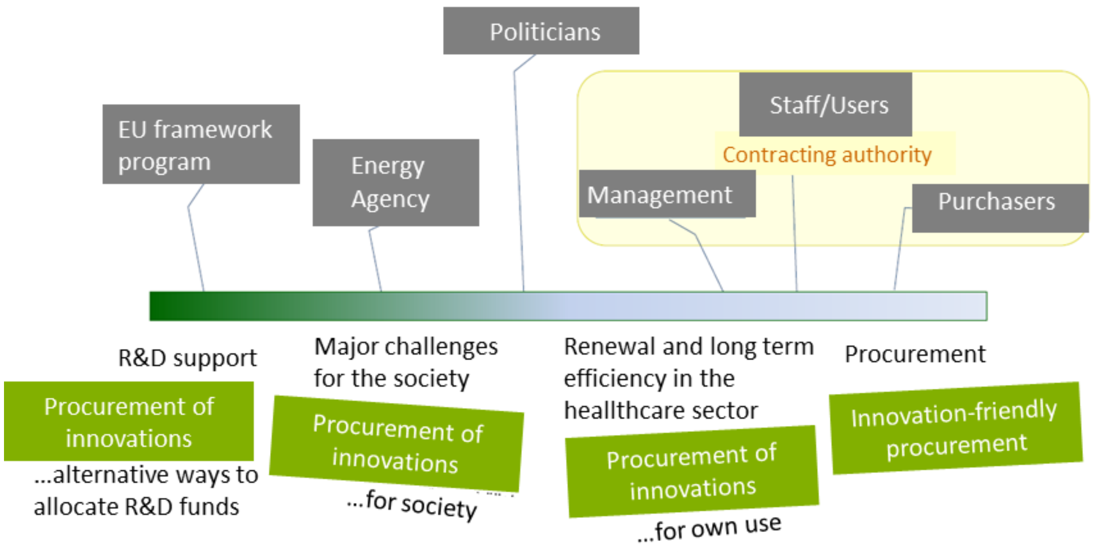


Figure 11 Innovation Procurement (Source: Vinnova).

6.3.2 Energy demand in health care premises over a twenty year period

Since 1990, the energy use in the health care sector has been reduced, as well as the energy used for space heating. Local boilers have been replaced by district heating, which has increased its share of the energy used for space heating by almost a factor two in one and a half decade (SEA, 2008). During the same period, the lighting equipment has become more energy-efficient, but electricity used for fans increased.

In Table 3, the energy use in health care premises 2006 and 2007 is presented in total and separately for hospitals, large medical centres (and polyclinics), retirement homes and rehab care centres (and similar). The energy mapping was made within the STIL-project, which included mapping of 159 health care premises in 26 Swedish municipalities (SEA, 2008). The total energy use in the premises was 218 kWh/m^2, year. In premises with a high energy use relative the floor area, this is often explained by high space heat demand. This can often be explained by the combination of poor insulation and high air flows with unsufficient heat recovery. A very low energy use can be explained by low use of electricity for ventilation and lighting and that there is no electric heating. However, a low energy use can also be explained by the fact that certain buildings are not in use or not occupied by the staff or clients (SEA, 2008).

Table 3 Energy use (kWh/m^2, year) in health care premises 2006-2007 (SEA, 2008)

	All categories	Hospitals	Large medical centres, polyclinics	Retirement home	Rehab care centres and similar
District heating	121.0	114.4	159.3	107.6	81.0
Oil	4.9	0.8	7.4	4.1	42.5
Natural gas	0.0	0.0	0.0	0.1	0.0

Stadsgas	0.3	0.0	0.0	0.0	6.1
Rötgas	0.0	0.0	0.0	0.0	0.0
Wood pellet	5.7	4.9	0.0	13.6	0.0
Wood chips	0.0	0.0	0.0	0.0	0.0
Wood	0.0	0.0	0.0	0.0	0.0
District cooling	3.0	6.0	0.0	0.0	0.0
Others	0.0	0.0	0.0	0.0	0.0
Electricity	83.1	96.0	70.5	66.0	81.9
Electric heating	*5.0*	*4.1*	*1.5*	*5.1*	*31.8*
Total energy use	**218.0**	**222.0**	**237.3**	**191.3**	**211.5**

Between 2009 and 2013, the average energy use in premises managed by Swedish regions and counties has been reduced by 5 %, see Table 4. In 2013, approximately 80 % of the energy used in all buildings (not only premises but also residential buildings) managed by Swedish regions and counties came from renewable energy (SKL, 2014).

Table 4 Energy use in premises and share of energy used in premises and residential buildings managed by Swedish regions and counties (SKl, 2014)

	Premises			Premises and residential buildings			
	Energy use in premises incl. electricity for health care services (normal-year adjusted)		*Premises' area (Atemp) per inhabitant*	*Share of renewable energy in buildings (premises and residential buildings)*		*Share of district heating*	*Share of renewable power in electricity use*
	kWh/m2		m2/inhabitant	%		%	%
Year	**2013**	**2009**	**2013**	**2013**	**2009**	**2013**	**2013**
Average non-weighted	215	227	1,8	79	71	78	80
Average weighted	219	230	1,4	81	74	78	85
Stockholms läns landsting	218	234	1,4	95	79	93	100
Landstinget i Uppsala Län	273	272	1,7	45	44	0	100
Landstinget Sörmland		254			97		
Landstinget i Östergötland	247	253	1,3	90	74	77	100
Landstinget i Jönköpings län	184	225	1,6	60	57	69	48
Landstinget Kronoberg	216	233	1,3	94	42	89	100
Landstinget i Kalmar län	198	209	1,6	98	97	97	100
Region Gotland	174	184	7,3	98	95	98	100
Landstinget Blekinge	228	255	1,8	95	90	77	100
Region Skåne	263	254	0,9	92	86	83	100
Region Halland	252	264	1,3	96		93	100
Västra Götalandsregionen	205	211	1,0	93	90	85	100
Landstinget i Värmland	161	179	1,4	99	41	97	100

Örebro läns landsting	232	240	2,0	39	44	65	0
Landstinget Västmanland	230	233	1,6	64	65	43	100
Landstinget Dalarna	170	183	1,4	92	77	84	100
Landstinget Gävleborg	214	208	1,4	97	90	94	100
Landstinget Västernorrland	201	213	2,1	29	46	47	0
Jämtlands Läns Landsting	191	201	1,3	99	97	99	100
Västerbottens läns landsting	234	264	2,0	41	42	80	0
Norrbottens läns landsting	214	227	2,2	72	67	81	60

6.3.3 Electricity use and potential reduction in health care premises

In 2006 and 2007, the total electricity use (excl. electricity for heating) in 159 health care premises included in the STIL-project was estimated at 77.8 kWh/m^2, year. In Figure 12 the electricity use is presented split into different categories of use. The highest share of the total electricity consumption was used in fans in the ventilation system (29.3 kWh/m^2, year). Also electricity for lighting corresponded to a high share (21.7 kWh/m^2, year) of the total electricity use. Health care facilities have high staffing 24 hours a day and need varied lighting. In total, the medical equipment only corresponded to 7 % of the electricity used in health care premises, of which X-ray equipment constituted the largest consumer (SEA, 2008).

As shown, the greatest potential for savings is within lighting and ventilation. At the time of the STIL-project, it was estimated that more energy-efficient lighting can reduce the electricity used by 12kWh/m^2 per year in the Swedish health care premises. It was also estimated that improved ventilation systems with air flows adjusted to the specific needs for the health care services could lead to a further reduction of the electricity use by 12 kWh/m^2, year. The health care floor area in Sweden of 21.000.000 m^2 implies that 0.5 TWh per year could be saved by these two measures (SEA, 2008).

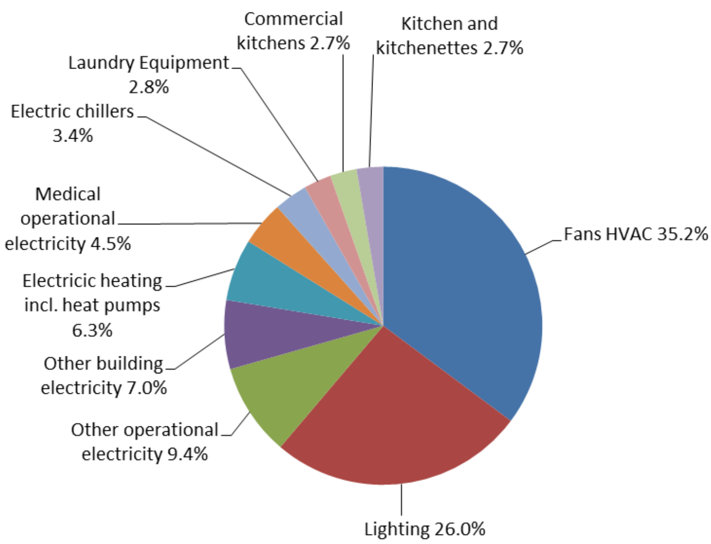


Figure 12 Electricity use in 159 health care premises in Sweden (SEA, 2008).

6.3.4 District heating

Today, all large cities in Sweden, and as many as 270 out of 290 Swedish municipalities, have district-heating systems (SDHA, 2009). According to energy statistics for 2010, Swedish district heating is supplying 58% of the heat used in dwellings and non-residential premises and as much as 93% of the heat used in apartment buildings (SEA, 2011b). In 2006 and 2007, district heating corresponded to 83.5% of the energy supply for space heating in the health care premises. The rest of the energy used for space heating came from heat-only boilers fuelled by wood pellet (3.9 %), oil (3.4%) and electric heating (3.4 %) as well as small amounts of city gas and district cooling (SEA, 2008). The transition towards district-heating also means a transition towards a higher share of renewable energy.

A complete assessment of the historic role of district heating in the Swedish energy system from a sustainability perspective is not possible without a comparison of potential alternative developments of local heating solutions. While such comparison would need further investigation, this section presents the historic development of district heating with regard to energy utilisation and environmental impacts.

In Figure 13, the historical Swedish district-heating production mix is presented in terms of energy input. As shown, after having been the primary fuel used in the 1970s, oil has been practically phased out as an input fuel to the Swedish district heating due to the oil crises in 1973-74 and 1980 (Sjödin, 2003) in addition to strong policy instruments. Today, oil is used mostly for peak load production during cold winter days. Fossil fuels (covering coal, natural gas, liquefied petroleum gas and oil) now represent about 10% of the energy input to Swedish district-heating systems.

Swedish district-heating systems have undergone increased diversification of fuel supply and an increased use of biofuels and waste; the expansion of the use of wood fuels and waste is especially large, as shown in Figure 14. Today, wood fuel is the most important primary energy supply in Swedish district-heating systems. The use of waste fuels has increased considerably, especially during the last decade since the ban on landfilling combustible waste was introduced (in 2002). There has been a slow gradual increase in the deliveries of industrial excess heat to the district-heating systems since the mid-1970s but there is still a potential for at least doubling the amount of industrial excess heat from the 3 TWh delivered in 2009 (Cronholm et al., 2009; GOS, 2011).

The integration of CHP plants in Swedish district-heating systems has been slow compare to other European countries – a phenomenon attributable to historically low electricity prices in Sweden compared to the prices in most other European countries due to the high share of hydro and nuclear power in the Swedish power supply mix. According to Sjödin (2003), the expansion of nuclear power was one important factor leading to the increased use of electric boilers and heat pumps in the 1980s. However, given the increasingly integrated European power system coupled with higher electricity prices also in Sweden, the use of electric boilers and heat pumps has continuously dropped.

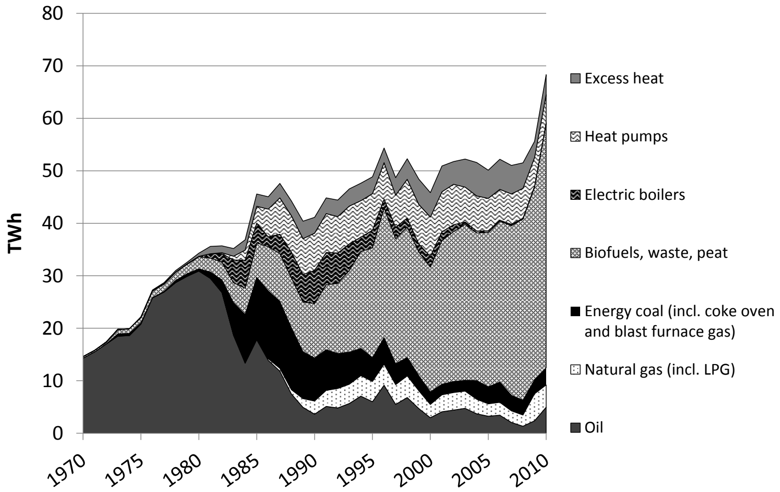


Figure 13 District heat supply in relation to energy input and technology in Sweden 1970-2010 (SEA, 2011b).

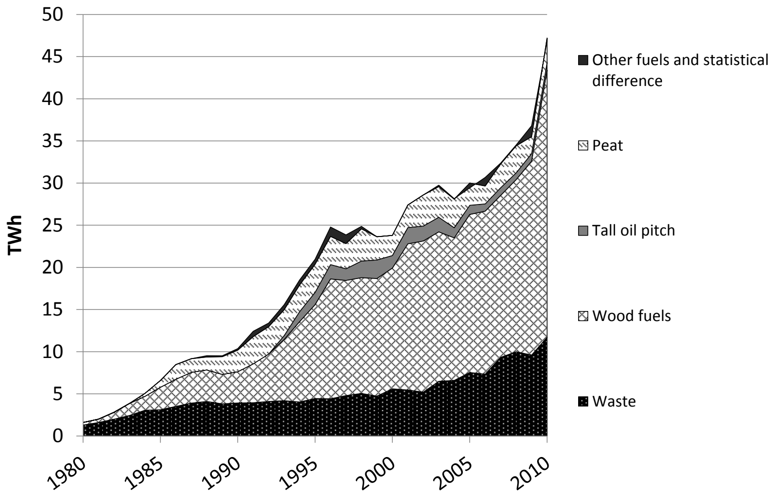


Figure 14 District heat supply based on waste, biomass fuels (wood fuels or tall oil pitch) and peat in Sweden 1980-2010 (SEA, 2011b).

According to Figure 15, district-heating generation increased by 35% between 1990 and 2009. During the same period, the power generated by CHP plants (excluding industrial back-pressure), condensing plants (excluding nuclear power plants) and gas turbines has increased by a factor four. Concurrently, annual CO_2 emissions increased by 4%, while emissions relative to the energy output (district heat and electricity) decreased by approximately 30%.

In the beginning of the 1990s, a refunded emission payment system for NOx emissions and a sulphur tax were implemented in Sweden (Sterner and Höglund Isaksson, 2006; Sterner and Köhlin, 2003). These environmental policies have resulted in strict emission controls, a situation that has improved the environmental performance of energy plants. Despite the increase of district-heating and power generation, annual emissions of NO_X and SO2 associated with this generation decreased by 5% and approximately 50%, respectively; this has resulted in lower emissions relative to the energy output (district heat and electricity) by approximately 40% and 70%, respectively.

Note that emissions from alternative power generation have not been taken into account. The net electricity generated by district-heating systems replaces alternatively generated power in the interconnected national power systems. This often implies the replacement of more polluting power generation based on fossil fuels. However, as power generation changes towards a more sustainable system that incorporates fuel switch, energy efficiency and pollution control measures, district-heating systems must also continue developing in this direction in order to be environmentally preferable to future alternative power generation solutions.

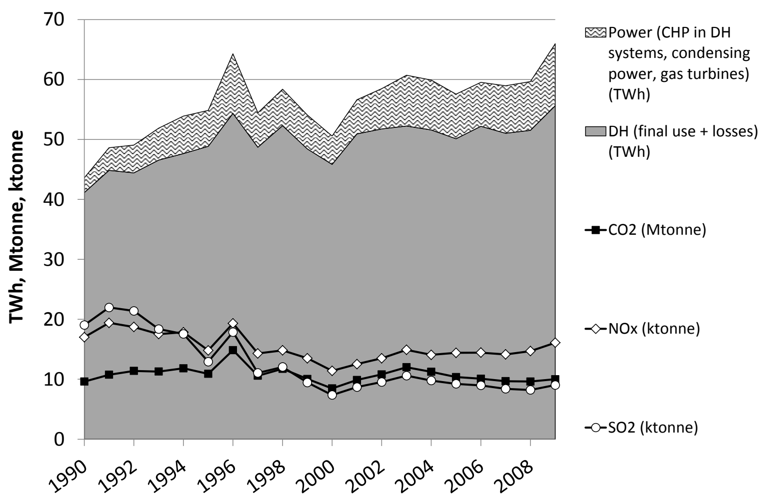


Figure 15 Generation of district heating (final use and losses) and power (in CHP, condensing plants and gasturbines, excluding industrial back-pressure and nuclear condensing plants) and associated emissions4 of CO_2, NO_X and SO_2 in Sweden 1990-2009 (SEA, 2011b).

6.3.5 District cooling

Today, many cities in Sweden also have district-cooling systems, even though the district cooling deliveries are much smaller than the district-heating deliveries. District cooling enables utilisation of free cooling from a nearby river, such as from the Göta älv river in Gothenburg, a nearby lake such as from the Saltsjön lake in Stockholm and from the sea, such as from the sea outside Malmö. In Göteborg, excess heat from the refineries is utilised to produce cooling in absorption chillers during summer. In Stockholm heat pumps are used to produce heat and cooling simultaneously. Electric chillers are also used to produce cooling in the Swedish district-cooling systems.

6.4 Conclusions

The investigation of Swedish best practices presented in this chapter indicates that the main goal of the STREAMER project – to reduce energy use and carbon dioxide emissions of new and retrofitted buildings in healthcare districts by 50 % – may be fulfilled by utilising technologies already available. This concluding discussion summarises the experience from different Swedish hospital projects and addresses the potential of implementing similar solutions in other European hospitals, for instance, by operational optimisations and by adapting a common BIM-oriented IT system. Finally, critical issues for further improvements of energy

[4] Emissions reported for Swedish power and DH generation also include emissions from coking plants, oil refineries and hazardous waste incineration.

performance of Swedish hospitals as well as the STREAMER contribution to the state of the art in Sweden are discussed.

6.4.1 Realistic STREAMER-goals

A lot of work has been undertaken during the last couple of decades in order to make the Swedish hospitals more energy efficient. This has resulted in an average energy use about 200-210 kWh/m2, year in premises owned by Västfastigheter and LOCUM. In 2013, the average annual use of electricity (including electricity for medical services) in LOCUM's premises is almost 100 kWh/m2 and the average energy use for space heating and hot water is 110 kWh/m2, year. This is a considerably lower energy use than for most European hospitals, which often have more than twice as high energy use. Thus, the energy use in European hospital buildings can be reduced significantly.

Nevertheless, the real estate owners of Swedish hospitals will reduce their energy use even further. For instance, today all new hospital buildings in Västra Götaland must have a maximum energy performance of 60 kWh/m2 per year (incl. user electricity). When renovating the existing building stock, the energy use must be reduced by 25%. This can be compared to old hospitals in need of renovation which may have an energy use of 300 kWh/m2, year.

6.4.2 Low-hanging fruits

The examples of best practices in Swedish hospitals presented in this report show that there is a large potential for energy savings by using already existing technologies, by optimising the operation of ventilation systems already installed and by utilising local energy sources. Examples of low-hanging fruits are listed below:

- **Operational optimisation.** By optimising the operation of ventilation and energy systems within the hospital areas, much energy can be saved without making any major investment.
- **Energy-efficient lighting**. Replacing light fixtures and light bulbs can save a lot of electricity at relatively small investment costs. Intelligent control of the lighting has the potential to reduce the electricity use even further.
- **District heating.** In Sweden, district heating has played an important role in order to achieve a resource-efficient supply to Swedish hospitals. District heating enables not only CHP generation, but also utilisation of local resources, such as municipal solid waste and biomass, other low-quality fuels and excess heat from industries. Because of the avoidance of emissions from other fuels, this may contribute not only to a more competitive and secure energy supply, but also to lower environmental impacts.
- **Free cooling.** Today, many Swedish hospitals are connected to district-cooling systems even though the district cooling deliveries are much smaller than the district-heating deliveries. District cooling enables utilisation of free cooling from a nearby river, a nearby lake or from the ocean. It is also possible to utilise excess heat, which otherwise would be wasted, to produce cooling in absorption chillers and, thereby, avoid emissions from other fuels. Depending on local conditions, consider the opportunity to utilise free cooling from the outdoor air, a nearby river, lake or ocean. In locations with rich amounts of snow, there is also the possibility of storing snow in the winter to be used for cooling in the summer.
- **Solar energy**. In a few years, when all new buildings should be so-called near-zero energy buildings, photovoltaics and solar thermal collectors may be important key technologies. The dramatic price drop of

photovoltaics has changed the preconditions considerably. In this report, examples of investments in solar energy technology have been presented. Of course, the potential for solar energy is even better for hospitals in the southern Europe than in a Nordic country like Sweden.

6.4.3 A successful process including BIM

One conclusion drawn is that the good energy efficiency already achieved among the Swedish hospitals is a result of the use of a BIM-oriented IT-system called Program for Technical Standard for hospitals (PTS). PTS is a fruit of the collaboration between all councils' real estate organisations in Sweden and this system has built up a common understanding of the needs in the various activities regarding building design, renovation of the interior and modern communication solutions.

This PTS system aims at strengthen the client's role through active assumption of responsibility, for acting correctly from start, involving clear instructions, guidelines that set value related goals and good solutions that can be reused. It is suggested that the STREAMER project should build up a similar BIM tool as the Swedish PTS to control all the aspects that affect energy use in a hospital building already at the drawing stadium. A common PTS will solve the limitations of the current knowledge and practice between all countries in Europe.

Building and rebuilding a hospital is complex. For instance, partnering has been pointed out as one successful form of cooperation where developers, consultants and contractors jointly solve the task. The method is based on an open and trusting partnership where everyone's skills complement each throughout the construction process. Regardless of contract form, a number of success factors for the early process are listed below:

- Goals and communication. Set clear goals to be achieved in the short and long term. Make sure that politicians, policy makers and technicians understand these goals and each other. All major stakeholders must agree on the goals. Convince decision-makers that there are other goals than just economy. Make sure that the goals are measurable and that they will be evaluated.
- Inventory analysis. Make an inventory analysis of the current situation and evaluate which measures will have the greatest impact.
- Innovative procurement. Choose the correct form of procurement for energy efficient medical equipment and for energy renovation projects.

6.4.4 STREAMER contribution to the state of the art in Sweden

There is not a lack of technologies to improve the energy performance even further in Swedish hospitals. Today, the main challenge in Swedish hospitals is to take the next steps towards energy-saving decisions that give big energy savings but that might not be economically feasible. This requires political courage as well as improved communication between politicians, officials and building management teams. The methodologies and tools regarding semantic-driven design methodologies including semantic BIM and GIS tools, which will be developed within the STREAMER-project, may help to avoid the risk of lack of communication between project partners and between different development phases of a project. This may facilitate for an even better basis for communication among different stakeholders and thereby also for a reduced energy use in Swedish hospital projects.

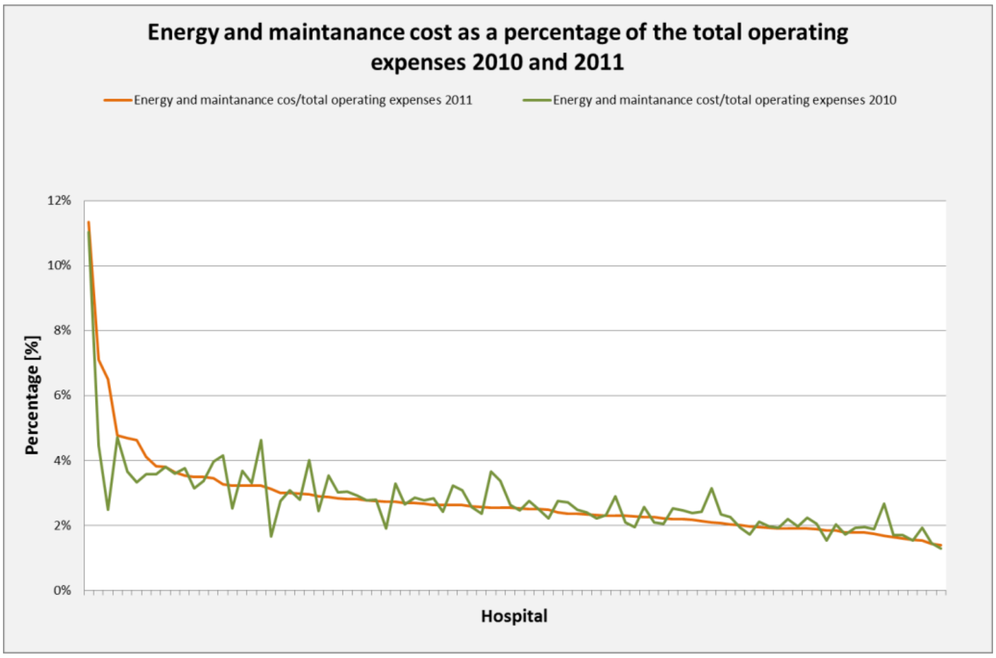
7. Dutch Section

7.1 Introduction

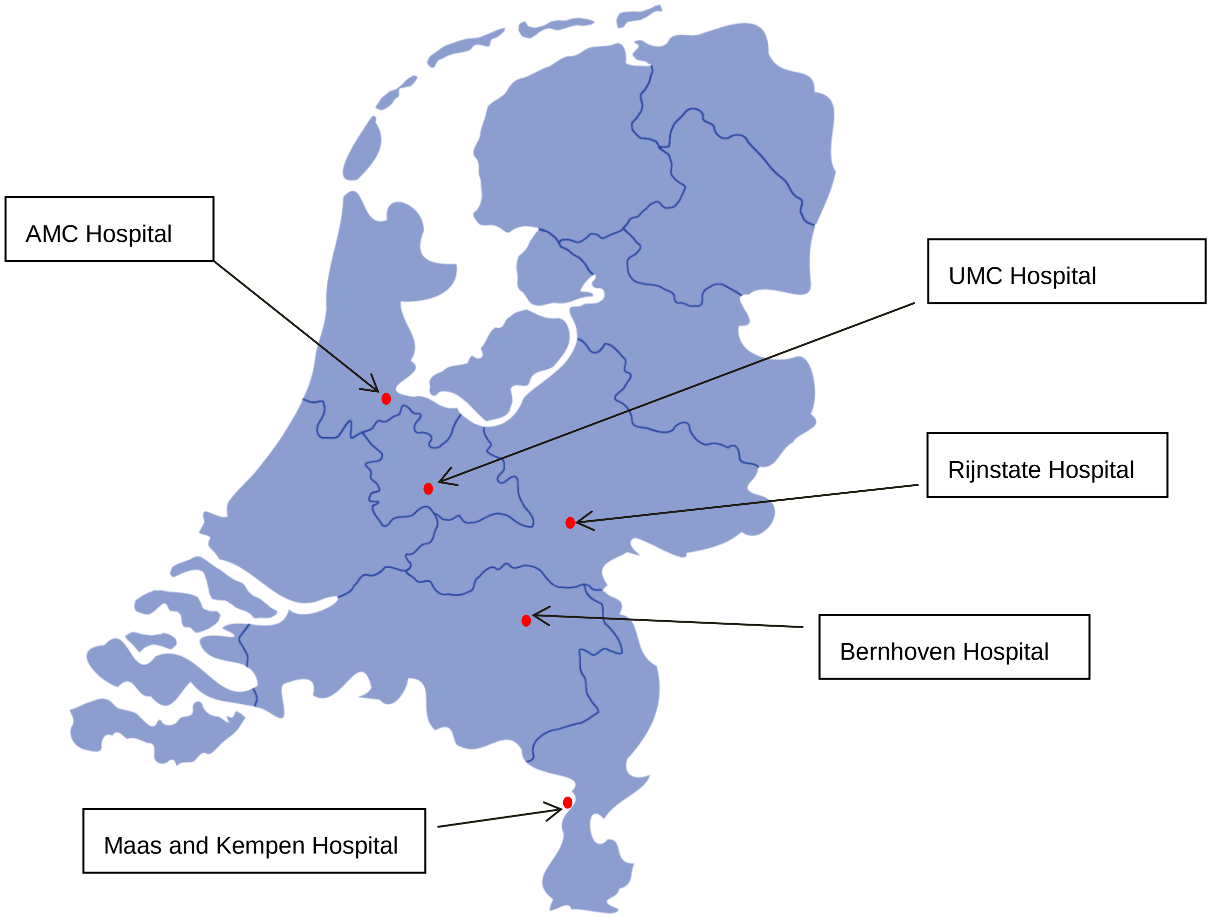
This deliverable is a State of The Art of building energy systems in some of the Dutch hospitals across the country and gives an overview of illustrative examples of the energy –efficiency initiatives that have been implemented. While, some technologies are innovative, others are examples of existing systems that in order to save more energy have been updated to more efficient systems.

The best practices described in this report contribute with some useful ideas for outlining the most effective methods in terms of contributing towards a maximum reduction CO_2 output considering location, environmental conditions and building needs within the healthcare sector.

The figure below gives an overview of the percentage of the energy cost and costs for maintenance of the building and installation compared to the total operational cost (staff, materials, capital cost, etc.) of a hospital in the Netherlands in 2010 and 2011. It is estimated that the energy cost of a Dutch hospital will be 1.5-2% of the total operational costs.



7.2 List of Dutch Hospitals that have made Energy Efficiency implementation



7.2.1 Ziekenhuis Maas en Kempen

Title	Ziekenhuis Maas en Kempen
Reference	Author: de Jong Gortemaker Algra, Stefan van Nederpelt year of publication: 2014
Status	PP: Restricted to other programme participants
Language	English
Outline	General project properties & concepts Architectural specifications Technical specifications
Relevance	Ziekenhuis Maas en Kempen is a new hospital in Belgium. It is state-of-the–art because it embodies recent organizational insights (TNO layer model).
Summary	<u>**General project properties:**</u> Project name: Ziekenhuis Maas en Kempen Location: Maaseik, Belgium Type of healthcare facility: General Hospital Type of construction: new build Planning + construction dates: start design 2008; completion 2016. A detailed overview of the size of the hospital can be found in the memo “analysis of m2 allocation in a new build hospital designed according to layer methodology”, dated 141119. Location:

	http://project.demobv.nl/streamer/Shared%20Documents/Forms/AllItems.aspx?RootFolder=%2fstreamer%2fShared%20Documents%2f13%20WP7%2fDeliverables%20for%20M18%2fDrafts&FolderCTID=0x0120002E82D5CE50A8CC4589162F983428E5E1&View=%7bD47F4D17%2d40F2%2d4354%2dBE4B%2dA21F317014FC%7d. To summarize, the factors gross floor area / net floor area are: • Entrance 2,08 • Office 1,92 • Hotel 1,81 • Industry 1,50 • Hot floor 2,17 • TOTAL 1,95 (=total gross area / total net floor area, as translated from PoR) Total Building costs: 45.000.000€ excl. VAT Architect: de Jong Gortemaker Algra / AR-TE Structural advisor: STABO Building physics advisor: STABO HVAC advisor: STABO Interior design: de Jong Gortemaker Algra **General concepts** Ziekenhuis Maas en Kempen (ZMK) is a new hospital in the town of Maaseik, Belgium. Three aspects have had a major part in the creation of the concept: creating a pleasant and healthy environment, clear logistics and an innovative real estate strategy (based on the TNO layer model). ZMK consists of five connected buildings, limited to 3 floors in height. These low buildings give the hospital a smaller presence, which is important to preserve the landscape quality. Also, it will make people feel less small when approaching the building. The facades represent the distinguishing characteristics of the buildings. For example, the building containing the core-hospital looks very high tech, while the facilitating building looks more utilitarian. The entrance, with its facades made of wood and glass, is very transparent. To visitors, this is the centre of the hospital. Here people can relax in the comfortable lobby, or in the restaurant which offers a nice view of the inner courtyard. A second important concept is the functional organization within five different buildings, interconnected by corridors. The grouping of functions by architectural requirements makes it possible to optimize the construction, building method, building services and finishing in every building, resulting in lower building costs and more flexibility (buildings can grow independently). The design process and planning are also influenced by this method. Changes made to a building do not affect the other buildings. This allows the client to add functions to the programme during the process. This is very important to a dynamic organization; too often hospitals are already outdated upon completion. This immediately saves renovation costs. This real estate strategy also leads to a clear logistical concept, in which the patients' and visitor's environment is separated from facilitating and core-hospital functions. The layout of the site also allows for separated routing for visitors and logistics. Technical: Main energy-saving measures: High-temp. Cooling and low-temp, Heating in floors (hotel) and climate ceilings (office, main circulation, part of the hot floor), Energy-recuperation of mechanical ventilation air, Openable windows in the hotel, PV panels, Wind turbine, Cogeneration. Thermal insulation is approximately 4,0m2K/W for the entire building envelope.
Relationship to STREAMER	• TNO layer model • 3D modelling • BIM • Patient comfort (healing environment) • Building flexibility • Internal flexibility
Additional comments	n/a
WP7 partner	De Jong Gortemaker Algra (P3)

7.2.2 Ziekenhuis Bernhoven

Title	**Ziekenhuis Bernhoven**
Reference	Author: de Jong Gortemaker Algra, Stefan van Nederpelt year of publication: 2014
Status	PP: Restricted to other programme participants
Language	English
Outline	General project properties & concepts Architectural specifications Technical specifications
Relevance	Ziekenhuis Bernoven is a new hospital in the Netherlands. It is state-of-the-art because it embodies recent organizational insights (TNO layer model) and complies with recent energy consumption regulations.
Summary	**<u>General project properties:</u>** Project name: Ziekenhuis Bernhoven Location: Uden, The Netherlans Type of healthcare facility: General Hospital Type of construction: new build Planning + construction dates: start design 2007; completion 2013 Gross floor area: 54.247m2 Factor gross floor area / net floor area: 1,70 Building costs: 47.000.000€ excl. VAT Building services costs: 36.800.000€ excl. VAT Architect: de Jong Gortemaker Algra Structural advisor: Aronsohn Building physics advisor: Peutz HVAC advisor: Royal Haskoning Interior design: de Jong Gortemaker Algra **<u>General concepts</u>** The building site is designed to provide maximum flexibility. Bernhoven occupies part of a rectangular structure that allows for future expansion or the addition of care-related functions. After the hospital was built, a care-hotel, nursery and a funeral centre have been added. The design concept of the hospital is based on the layer model, as developed by TNO. Bernhoven consists of five interconnected buildings, each with its own specific functions. The Hot-Floor and offices are expected to grow the most. The design allows for a 30% growth without changing the existing structure. Internal flexibility is guaranteed by the column structure. The amount of load-bearing walls has been minimised. Special attention has been paid to the experience of the patient and visitors; the low-intensive care and the hotel are easily accessible but the high-intensive care is only visible for patients who need it. Due to the prominent patios, daylight and the experience of nature has become part of the hospital experience. In addition, also the interior design contains many images of nature. <u>Technical:</u> Main energy-saving measures: ➢ High-temp. Cooling and low-temp. heating ➢ Variable-speed drive (VSD) pumps ➢ Night ventilation where possible ➢ High- frequent lighting

	➢ optimization HVAC-systems ➢ Two-way control system to optimize heating and cooling system ➢ sensible and latent heat recovery unit from waste air ➢ variable-frequency drive (VFD) fan ➢ combined heat and power (CHP) system Calculated building energy performance is 5% better than demanded by Dutch regulations (2009). Building envelope insulation: ➢ Roof: 4,0m2K/W ➢ Ground floor: 4,0m2K/W ➢ Facades: 3,0 m2K/W and 3,5 m2K/W ➢ Glazing U-value: 1,8 W/m2K
Relationship to STREAMER	➢ TNO layer model ➢ 3D modeling ➢ BIM ➢ Patient comfort (healing environment) ➢ Building flexibility ➢ Internal flexibility
Additional comments	n/a
WP7 partner	De Jong Gortemaker Algra (P3)

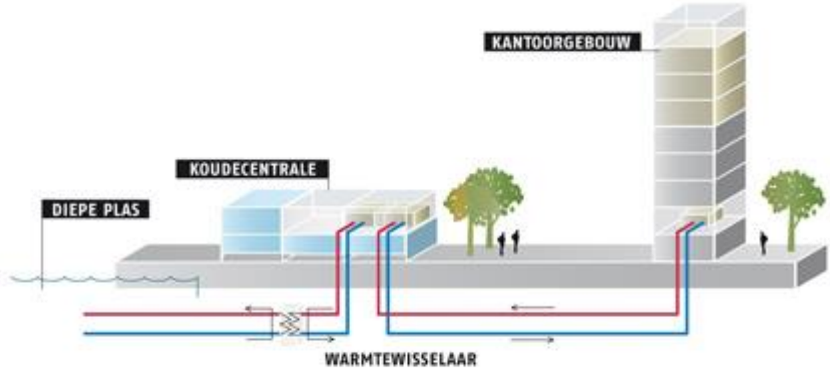
7.2.3 Academic Medical Center (AMC) Amsterdam

TITLE	Renovation Powerplant of the Academic Medical Centre (AMC) Amsterdam
Reference	➢ Website https://www.amc.nl ➢ Projectpagina, Engelstalig: zie http://www.dwa.nl/?detail_id=10860 ➢ Filmpje AMC, Engelstalig: zie ➢ https://www.youtube.com/watch?v=Eu3Hkqes6Xo
Status	Publicly available
Language	Dutch & English
Outline	AMC Amsterdam is an academic hospital. The AMC can be characterised as follows: ➢ 1,000 beds ➢ 7,000+ employees ➢ 2,300 medical students ➢ 400,000 m² floor area The AMC Amsterdam has an own power station that generates all necessary utilities. The project covers all utilities for the AMC: heating (hot water, steam), cooling, (emergency) power, breathing air, hot & cold potable water, and several water treatment systems. Also the control & monitoring facilities are completely renewed and state of the art. The core of the energy concept is a dual fuel CHP plant, completed with external sustainable city cooling. Primary function of the CHP units is uninterrupted delivery of electrical power
Relevance	Combination of emergency power and efficient utility generation by means of CHP (WP2). Example of using natural cooling in a hospital. Energy supply of a large academic hospital.
Summary	 **Backgrounds** The AMC in Amsterdam has completely renovated its utilities in the period 2005 - 2013. Practically all subsystems and installations have been replaced, renovated or extended. In fact this renovation process was more complex than a green field new building of the power plant. **CHP and emergency power** The heart of the power plant is formed by three dual-fuel combined heat and power (CHP) units. This CHP plant provides AMC with electricity. The new installation is more energy-efficient than its predecessor, and causes less air pollution. The AMC has been using a HFO-fuelled CHP plant to generate electricity for

nearly 30 years now. Its electricity supply is thus ´no break´ ensured, even in the case of a grid failure. The old power plant had more than reached the end of its technical life, while at the same time AMC's power requirements had grown and environmental standards had become much stricter. For that reason, it was decided to rebuild the power plant completely. The new power plant has an electrical output of 12 megawatt – enough to meet the electricity requirements of a medium-sized town. The dual fuel option means that in case of natural gas supply failure, the CHP units will automatically switch over to diesel fuel, without any interruption.

Heating & cooling

Heat recovery is more efficient, and the flue gases from the new power plant are cleaned more effectively so that less CO_2, SO_2 and NO_x will be emitted. The new power plant gets part of its cooling power for HVAC purposes from the Ouderkerkerplas (Lake of Ouderkerk). The water at the bottom of the lake is at a constant temperature of 6 °C or even lower. It is pumped up for use in AMC's chilled water system, and returned to the lake after use



Data

<u>Specification</u>

- Electrical power: 12 MWe
- Heating power: 50 MWt
- Cooling power: 30 MWt
- Breathing air: 1.500 m_n^3/h

<u>Emission reduction and energy efficiency</u> (reference: no CHP)

- CO_2-emission reduction: 16.190 t/a
- Energy consumption reduction: 289 TJ/a
- Energy-efficiency improvement: 28%
- NOx-emission reduction: approx. 580 t/a
- SO_2-emission reduction: approx. 90 t/a

Relationship to STREAMER	Direct link to Task 2.3 in Streamer project. (Smart) Energy supply of a complete hospital campus.
WP7 partner	DWA (P6)

Figure 16 Chilled water plant

Figure 17 Hot water distribution

Figure 18 Dual Fuel CHP unit 4,1 MWe

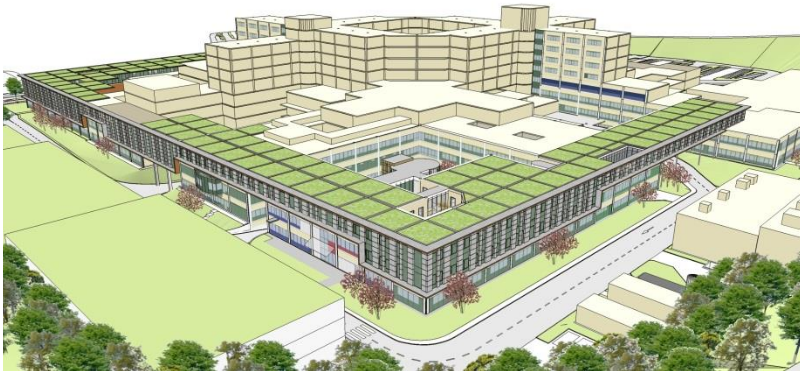
7.2.4 University Medical Center (UMC) Utrecht

TITLE	Powerplant University Medical Center (UMC) Utrecht
Reference	➢ Website English http://www.umcutrecht.nl/en/-1 ➢ Projectblad UMC, Nederlandstalig ➢ Projectpagina, Engelstalig: zie http://www.dwa.nl/?detail_id=12465
Status	Publicly available
Language	Dutch & english
Outline	The UMC Utrecht is an academic hospital. The UMC Utrecht can be characterised as follows: ➢ 1.000 beds ➢ 12.000 employees ➢ Approx. 300,000 m² floor area The project covers the replacement of the existing gas fired CHP units, exhaust gas boilers and extension of the cooling capacity. The project covers most utilities: heating (hot water, steam), cooling, (emergency) power and hot potable water. The core of the energy concept is a gas fired CHP plant, consisting of three identical units. Primary function of the CHP units is uninterrupted delivery of electrical power.
Relevance	Combination of emergency power and efficient utility generation by means of CHP (WP2). Energy supply of a large academic hospital.
Summary	 **Background** The UMC Utrecht has an own power station that generates all necessary utilities. In 2003, the three existing 1 MWe gas fired CHP units were technically end of life. It was decided to replace the CHP units by modern, lean burn gas fired CHP units. The anticipated capacity was increased due to the on-going electrification of the medical installations and expansion of the hospital. The selected medium speed CHP units have an output power of 2,15 MWe **Emergency power** The CHP units provide the no break emergency power supply for the UMC for the situation that there is a grid failure. In case of natural gas supply failure, a 2.8 MWe emergency diesel generator set is available. The electrical distribution system is designed for active load management in island operation; the load is adapted to the available generating capacity. In normal situation (all

	units available) there a no or less operational restrictions. **Heat recovery** Heat recovery is optimised, so that all over the year the heating power of the CHP units can be used for steam, hot water generation, and hot potable water and cooling. The exhaust gasses are combined into one exhaust gas boiler. Space restrictions have led to this configuration. Load management of the CHP units is based on heat demand. Surplus heating power in summer time is used by a 1.500 kWt absorption cooling machine. The complete heat production of the CHP units can be used, even the low temperature systems are used for domestic heating. Total annual energy efficiency is approx. 85% or better. For a 30+ year old hospital this is an excellent performance. **Modular renovation** The replacement of the CHP units and exhaust gas boilers and all auxiliary equipment has been done step by step. Each step contained one CHP units and all its supporting systems. During the replacement of the CHP units an external emergency genset was installed. The renovation process had no consequence for the power supply to the hospital. **Data** ➢ Electrical power 6.5 MWe ➢ Thermal power (CHP) 7.3 MWt ➢ Steam boiler 5,1 t/h @ 7 bar ➢ Absorption cooling 1.5 MWt ➢ CHP units Wärtsilä 12V220SG ➢ Total efficiency > 85%
Relationship to STREAMER	Direct link to Task 2.3 in Streamer project. (Smart) Energy supply of a complete hospital campus.
Additional comments	n/a
WP7 partner	DWA (P6)

7.2.5 Rijnstate Ziekenhuis, Arnhem

TITLE	Rijnstate Hospital, Arnhem
Reference	➢ Website Dutch: http://www.rijnstate.nl/web/show ➢ Project master plan described in detail in deliverable D7.3
Status	Publicly not yet available
Language	English
Outline	Rijnstate Hospital is a Teaching Hospital which was opened in 1996 on the site of a former hospital and is currently one of the 4 the demonstration sites in the STREAMER project. The current building of Rijnstate measures 72.000 m^2, in an area of approximately 89.000 m^2. Rijnstate Arnhem has a total energy consumption of 128.705 GJ. Over the multiple locations, the hospital has a total area of 112,000 m2 and serves 480.000 patients every year. Rijnstate is a non-profit private entity (foundation). Around 5.000 staff

	work at Rijnstate, of who more than 300 medical doctors. Rijnstate is an academic hospital liaised with the Radboud university and academic medical centre in Nijmegen. Some key figures (2011): • 955 hospital beds • 39,250 patient admissions (stay) • 41,000 patient admissions (day) • 588,300 policlinic patients • 28 specialist care units • 31 medical trainings • 15 Intensive Care (IC) beds • 22 surgery / operation rooms • 4958 staff • 317 medical specialists • 550 voluntary staff • - 23% - 77% proportion of men – women staff
Relevance	Combination of retrofitting MEP systems main building and extension of hospital building. BIM modelling of MEP and HVAC systems for newly developed wing.
Summary	The newly developed expansion North East of 5.000 m^2, phase 1 of the earlier mentioned Master plan, was proposed as live project, together with the final design of the MEP systems. As the project was already partly developed, it would be a so called "*shadow engineering*" project, meaning the project was already available designed in 2D, and would be redesigned in 3D-BIM. At the same time Rijnstate started to make use of Brief Builder software, which proved useful in relation to the STREAMER ambitions.  The hospital is in need of expansion of 10.000 m^2 to incorporate necessary services. With the knowledge that Rijnstate Hospital will need a midlife renovation around the year 2016 and at the same time, with the knowledge that the hospital will require future expansion, research has been started to investigate ways, how to achieve its ambitions in a cost effective way and at the same time do so in the most sustainable manner, reducing the output of carbon dioxide gasses as much as possible. The master plan resulted in a design which is shown in the picture below. The green roof area is the planned extension of 10.000 m^2. Parallel to this, Rijnstate has determined its ambition to reduce the footprint by 50% in 2020. Currently, Rijnstate is preparing a 10,000 m^2 (phase 1: 5.000 m^2 being realized) large-scale extension. The project aims to add several new outpatient buildings, improve the public space for visitors, and create a healing environment for patients and high-quality workspaces. The project will be

	combined with the mid-life renovation planned for 2016 (and after) to replace the existing, outdated MEP systems with an up-to-date green system with minimum or zero CO2 emission. Part of the RNS demonstration case includes an expansion of the existing building with 5.000 m^2, where the oncology center and vascular center is housed. The new building contains mostly outpatient functions. The new expansion is visible in the picture below: it is the building part with the green roofing. 
Relationship to STREAMER	Scope of the energy-efficient demonstration case for STREAMER, focusing on the design stage: Based on the new integrated Master Plan –which incorporates the goals concerning architecture, landscape, infrastructure, parking and logistics– 5 design scenarios for the extension and large scale renovation are examined regarding the feasibility in terms of Total Cost of Ownership (TCO) and, at the same time, the contribution to reduction of energy use and CO2 emission. BIM and GIS will be used at this early-design stage to analyse the 6 scenarios as well as to map the CO2 footprint of the healthcare district prior to decision-making. Targeted real impacts through this STREAMER demonstration case: Energy-related investigation in this project focuses on new systems at building and neighborhood scale based on renewable energy sources.
Additional comments	The main objective to introduce the Building Information Model and to understand and determine how BIM can facilitate / contribute to the choice which of the 6 scenarios developed within D7.3 will be the most effective in terms of contributing towards a maximum reduction CO2 output in combination with the total cost of ownership.
WP7 partner	RNS (P13)

7.3 Best current practices regarding energy-efficiency

7.3.1 Best practices – summary of best practice experience in the realization of sustainable Healthcare buildings

7.3.1.1 Process-related

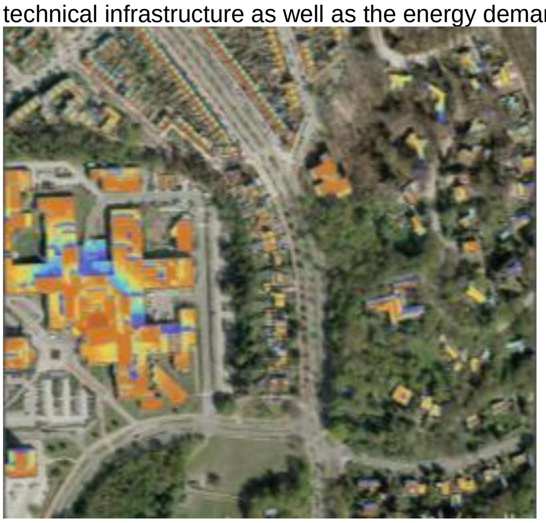
- All partners within the design team should have the same ambition level and the willingness to make an effort in creating sustainable solutions.
- Sustainability should be on the agenda from the beginning of the project. (starting with the choice of site location)
- In the case of handover of the project to a contractor who may not be aware of the sustainability-agenda, care must be taken to explain the importance of sustainability in the broadest sense within the design.

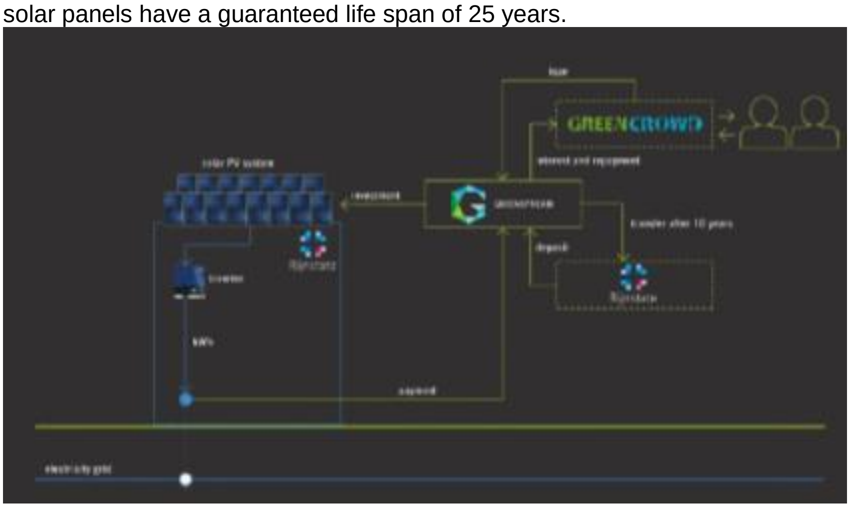
- It helps to set goals and to keep track of them during the process. This can be done using BREEAM, Greencalc (for the Dutch market) or any other method.
- Subsidies can stimulate high ambition levels and improve the return on investment time.
- Collaboration between architect, constructor and building services consultants within a BIM environment increases the awareness of design decisions throughout the team. This allows for an interdisciplinary design approach and results in higher building performance

7.3.1.2 Design-related

- Technical developments, especially in the PV panel market, should be closely watched. Currently, the return on investment time is often considered insufficient, but this is about to change.
- Attention should also be paid to the energy consumption of user-equipment. These have a considerable impact on total energy consumption.
- The scope on sustainability should not be limited to energy. Building materials, water usage, building flexibility, waste and site quality are all part of the sustainability agenda.
- Manufacturers and suppliers with sustainable products should be preferred.

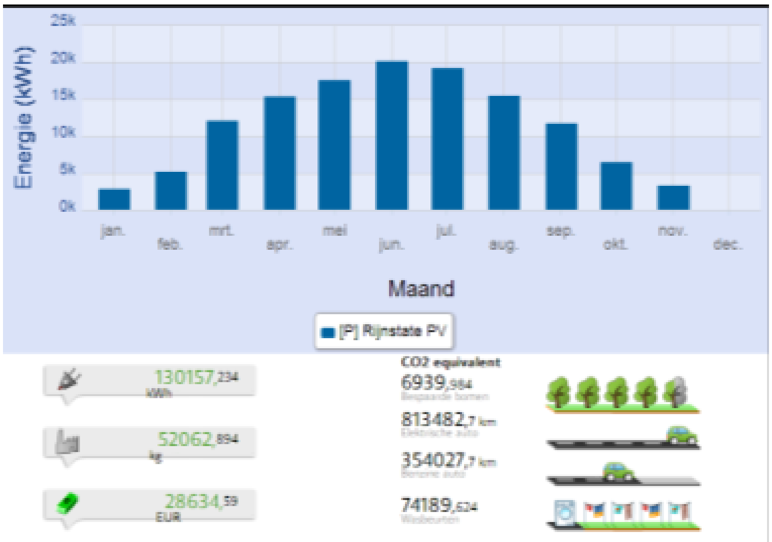
7.3.1.3 Building-related

TITLE	Solar PV System Rijnstate Hospital
Reference	Photo Book English
Status	Publicly available
Language	Dutch & English
Outline	Mid-2013, Greenspread assessed the feasibility of the solar PV system from technical and financial perspectives. The most advantageous system was proven to consist of 660 solar panels, with an annual power output of 145.000 kWh. Such an energy yield equals the average need of 42 Dutch households. Greenspread calculated the solar irradiation on the location, the carrying capacity of all roof segments involved and the compatibility with the electro-technical infrastructure as well as the energy demand pattern of Rijnstate.  In addition, Greenspread developed a business case in cooperation with Rijnstate and designed a tailor-made financing plan. In brief, Greenspread finances the solar PV system, while Rijnstate pays Greenspread for all

	renewable energy production in conformity with a supply contract. After this period, Greenspread transfers the property of the PV system to Rijnstate. The solar panels have a guaranteed life span of 25 years. 
Relevance	From 2015 on, surrounding households will be supplied with the green power that is produced on the roofs of Rijnstate, by means of “Guarantees of Origin”. In this process, the local green energy cooperation “Rijn en IJssel” is the driving force. Greenspread’s permit to serve as a utility is crucial for the administrative organisation of the energy supply.
Summary	**Background/Realisation** After the crowdfunding process, the solar PV system has been installed on ten different roof segments of the hospital. Altogether, this took two full weeks, making use of a 60 meters high tower crane. The total solar PV system consists of 660 solar panels, 10 inverters, more than 5 kilometres of cable and 33 tons of ballast. The solar system is joined with the internal electricity network of Rijnstate by way of four medium voltage power connections. During the construction process, the robustness of the system was immediately tested by the heavy storm that ravaged the Netherlands on the 28th of October 2013. **Exploitation** After the commissioning of the system, the power supply contract between Rijnstate and Greenspread commenced. For ten consecutive years, Greenspread is accountable for the operation and maintenance of the full solar PV system. Rijnstate is only being charged for the truly produced amount of solar power. Thus, Rijnstate is making use of solar energy and is not subjected to any risks.

Data

The solar PV system on the roof of hospital Rijnstate in Arnhem (the Netherlands) consists of 660 solar panels and has an annual power output of 145.000 kWh. This electricity output equals the need of 42 average Dutch households. The PV system is the largest in Arnhem and surroundings.



Overview energy saving per month

Relationship to STREAMER

Task 7.3 in STREAMER:

- Description and outlined design plan (requirements, typology model, conceptual building design in open- BIM/GIS format

Task 7.4 in STREAMER:

- Validation through participatory design session (design workshop). During this workshop the preliminary design models are verified using preliminary performance simulation and assessment tool as developed within the project.

Additional comments

WP7 partner

RNS (P7)

TITLE	Energy efficient LED lights
Reference	http://www.rijnstate.nl/web/Over-Rijnstate/Duurzaam-ondernemen-1/Bijdragen-aan-milieu/Energiezuinige-verlichting.htm
Status	Publicly
Language	Dutch/ English

Outline	The energy consumption for lighting represents 20 to 25% of the hospital's total energy consumption.
Summary	In this context, the hospital management has decided to switch on energy-efficient lighting, such as bulbs and energy-efficient fluorescent and LED lighting. Daylight control is now being used for new construction projects at all the hospital locations. This means that the intensity of the lamp light adapts to the amount of daylight that enters the building. In addition, the light switchers have been replaced with motion sensors.
Relationship to STREAMER	Direct link to Task 7.3 in Streamer project: ➢ Description and outlined design plan (requirements, typology model, conceptual building design in open- BIM/GIS format Direct link to Task 7.4: ➢ Validation through participatory design session (design workshop). During this workshop the preliminary design models are verified using preliminary performance simulation and assessment tool as developed within the project.
WP7 partner	RNS (P7)

7.4 Conclusion

Healthcare buildings and districts are among the EU priorities for energy efficient buildings since they play a key factor for sustainable community but their energy use and carbon emission are among the highest of all building types. The present overview addressed the initiatives that some hospitals in the Netherlands have implemented in order to cope with the energy crisis, as to substantially reduce/ or optimise their energy consumption and carbon emission by 30-50%.

We have here incorporated only few best practices from past and current projects that describe the innovative energy-efficient measures and their impact on the buildings energy consumption however we must not forget the important role of a good and capable (energy) management staff.

In a wider sense, we can conclude that energy management is a way of improving the energy efficiency in an existing building by continuously striving towards decreased energy consumption. This includes operating and maintaining the building in a way that sustainable energy efficiency gains are achieved. Even at the design stage of a building (or an extension plan), as well as considering its energy-efficient design and that of the installations, attention should also be paid to the future energy management needs of the building. These needs include the ability to measure and monitor energy consumption of the different energy end-uses.

8. French Section

8.1 Introduction

8.1.1 Brief presentation of the French context

In Metropolitan France and Overseas Departments and Territories (excluding Mayotte) there are 2 694 healthcare entities which offer a wide variety of services and present very different structures, legal status and sizes (947 public entities and 1,747 private entities). They offer around 414,000 full time hospitalization beds and around 65,000 partial hospitalization rooms.

8.1.2 Energy efficiency potential in French hospitals:

The energy issue is not just a question of economical concern for hospitals any more but it is also more and more linked to environmental and societal preoccupations (increasing scarcity of resources, hospital's reputation/image, respect of European and national environmental regulations, etc.).

Energy is an essential and an inherent element for the proper functioning of a hospital. Its daily use can be found in many different ways, especially through:

- Electricity consumption: for the functioning of medical installation, IT equipment, lighting, air conditioning, etc.;
- Steam and gas consumption: for heating and domestic hot water;
- Fuel oil: for the emergency generators.

The main difficulty for a hospital (when compared with other buildings of the service sector) is that it has to ensure, in some parts of its facilities, a non-stop availability of energy supply in order to guarantee the expected safety and quality care for the patients.

Nevertheless, although the energy consumption of a hospital is currently important, a lot of actions / technical solutions can be implemented in order to improve energy consumption and consequently, to have more efficient energy buildings.

8.2 List of French Hospitals that have made Energy Efficiency implementation

8.2.1 La Pitié Salpêtrière (Paris)

TITLE	Healthcare district : La Pitié Salpêtrière (Paris) Building : E3M Institute (Endocrinology, Metabolic Diseases and Internal Medicine)
Reference	Internal documents
Status	Access limited to consortium partners
Language	French
Outline	This Institute, built in 2011-2013, meets the criteria of: ➢ the French "High Environmental Quality" certification (first healthcare building to obtain this certification) ➢ the French “Energy High Performance” Label with the “Energy Very High Performance” level
Relevance	Reducing energy demand thanks to the conception of the building
Summary	The Institute is housed in a 14,902-m² (net floor area) building located on the Pitié Salpétrière heathcare district. To be certified "High Environmental Quality", the building has to meet 14 specific targets (including one target related to energy management and another one related to the long-lasting of environmental performances). For each target, the different levels can be: “base” level, “efficient” level or “very efficient” level. In the E3M Institute case, the energy management is assessed as “efficient” and the long-lasting of environmental performances is assessed as “very efficient”. The criteria for the “energy management” topic include : - reduction of energy demand through building design - limitation of primary energy consumptions - use of efficient systems and of renewable energies - reduction of pollutant emissions To get the “Energy High Performance” label, the annual energy consumption has to be 20% inferior to the reference consumption as mentioned in the 2005 French thermal regulation. As the building started to operate in December 2013, we still do not have all the information for 2014. However, the consumption estimate per square meter amounts to around 185-200 kWh/m²/year (electricity and thermal energies). The performance of the building’s energy consumption is mainly based on: ➢ an efficient thermal envelope; ➢ a low-powered artificial lightning installation; ➢ the connection with the Paris urban heating system; ➢ Fan coil units with low-powered ventilators.
Relationship to STREAMER	This case can be linked to the design and conception phases when building a new hospital (optimization of the consumptions through a carefully-thought project)
WP7 partner	APH/BOU

8.2.2 Ajaccio hospital

Title	Ajaccio hospital
Reference	http://etablissements.fhf.fr/annuaire/hopital-fiche.php?id=453
Status	Some communications from the hospital will be public.
Language	French
Outline	The Ajaccio public authority has launched the renewing of its hospital with the construction of a complete new building. All the design, construction then exploitation of the Hospital is performed using BIM.
Relevance	All the concept of the STREAMER project, including BIM, collaborative work using PLM, energy efficiency questions... are part of the Ajaccio hospital project.
Summary	The new Ajaccio hospital is a 36000m2 building with 326 beds and all associated spaces and equipment. The main contractor and constructor of the project is the Italian company INSO. Members of the construction consortium are: Architecture is performed by AART, the structural office is BERIM, the MEP and hospital technics development is developed by SNC Lavalin, the energy and environmental impact analysis are performed by OASIIS. CSTB is member of this consortium and is responsible of the BIM protocol. All the steps of the projects are performed using BIM, for design, analysis, collaborative work and links with the exploitation tools (facility management, building monitoring). A PLM platform is used for the aggregation of the different BIM models and associated documents (technical & administrative) and also for the contractual workflow process betwwen the contractor and the owner of the hospital, including the control offices.
Relationship to STREAMER	The very operational work performed within this Ajaccio hospital project will serve for the state of the art and experience return for the STREAMER project.
Additional comments	
WP7 partner	CSTB, APHP

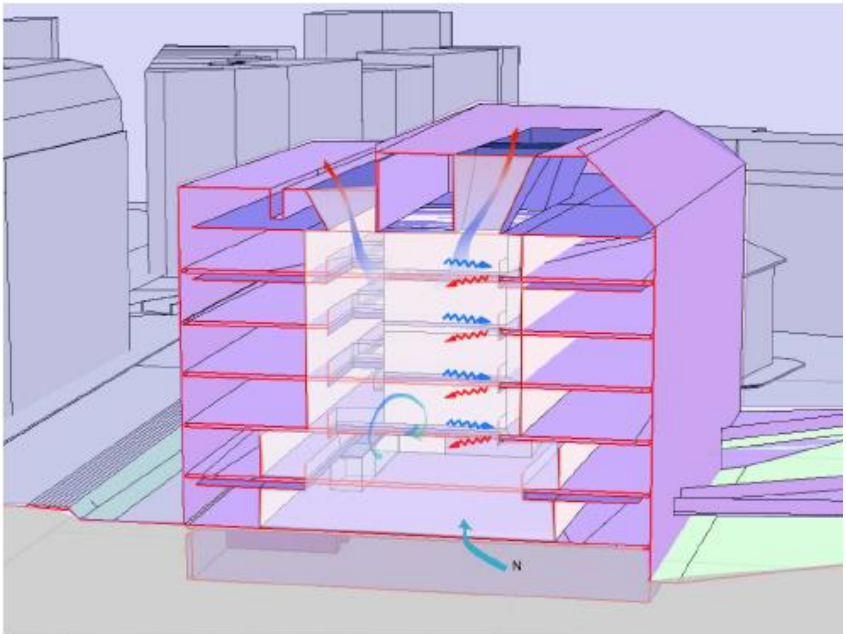
8.2.3 Avicenne (Bobigny – north-east of Paris)

TITLE	Healthcare district : Avicenne (Bobigny – north-east of Paris) Building : Power station
Reference	Internal documents
Status	Access limited to consortium partners
Language	French
Outline	This power station, built in 2012-2014, started to operate during the 2nd semester 2014 and the boiler runs on biomass
Relevance	Use of renewable energy
Summary	The power station includes a biomass boiler, a new domestic hot water supply network which supplies the whole hospital and a new secured high voltage electric installation with an unique emergency station (before, the emergency generators were scattered on different parts of the district). The 3 MW biomass-boilers covers around 80% of the healthcare district’s needs and this is completed with 3 gas/domestic heating oil -boilers which makes it possible to supply the district 24h/24.

	Besides, around 4,370 T CO_2 will be saved per year.
Relationship to STREAMER	The use of renewable energy matches STREAMER's expectations.
Additional comments	One similar project is currently on progress regarding the installation of a biomass boiler (Charles Foix hospital)
WP7 partner	APH

8.2.4 Necker (Paris)

TITLE	**Healthcare district : Necker (Paris)** **Building : Imagine Institute**
Reference	Internal documents
Status	Confidential
Language	French
Outline	Cooling down the atrium thanks to natural ventilation
Relevance	Reducing energy demand thanks to the conception of the building
Summary	The Institute is housed in a 19,000-m² building located on the campus of the Necker Enfants Malades Hospital, and brings together over 450 researchers, doctors and healthcare personnel. Set up around a vast atrium bathed in natural light, it consists of: ➢ Research areas with laboratories and efficient technical facilities ➢ Areas for clinical care intended for genetic consultations ➢ A clinical investigation centre ➢ A biological resource centre ➢ Rare diseases reference centres The atrium serves as a waiting area for the clinical care on the ground floor and is surrounded from the 1st to the 5th floor by the interior balconies of the labs. It is naturally lit by a glass roof. Inside this building, the main problem consists in evacuating the excess of heat due to the internal heat load. It has been decided to restrict the number of air-conditioned areas (decision based on the specificity of each research lab and the equipment to be found inside these labs). To help cooling the indoor air in summer, the solution consists in taking advantage of the difference of temperature between the indoor and outdoor air. The freshness of the colder air is accumulating into the inertia of the building and the natural ventilation evacuates the warmed-up air. The building inertia was increased by its structure, concrete floors and walls. The natural ventilation is used during the mid-season and the summer nights when the different air temperatures (indoor/outdoor) allow it. The ventilation system is then stopped automatically thereby allowing energy savings.

	The natural ventilation of the atrium is buoyancy driven, meaning that hot air, being heavier than cold air, floats up. To achieve this, several intakes are situated in the garden conveying the cold air into the lower part of the atrium. The hot air is evacuated through windows openings placed on the top of the atrium designed specifically for that reason. The intakes and the windows are controlled by the building management system. Simply put, when the outside air is colder than the air inside of the atrium the intakes and the windows are opened to put in movement this natural pump and the mechanical machines are cut. On the contrary, when the conditions are not met everything is closed and the mechanical ventilation continues. Of course other conditions need to be met, to avoid discomfort such as minimal outside temperature, maximal air speed or maximum outside temperature. This natural ventilation improves the comfort of the patients in the waiting area and enables energy savings for the labs situated around the atrium. 
Relationship to STREAMER	This example illustrates the reduction of energy demand thanks to its conception.
WP7 partner	APH

8.2.5 Felix Guyon University Hospital (Reunion Island)

TITLE	**Healthcare district : Felix Guyon University Hospital (Reunion Island)**
Reference	**http://www.chr-reunion.fr/IMG/pdf/DP_ISO_50001_ok.pdf**
Status	Publicly available

Language	French
Outline	First French Hospital to be certified ISO 50001-2011(energy management system)
Relevance	Reducing energy demand
Summary	The hospital wrote an energy policy that sets goals and objectives in terms of electricity, fuel oil and water consumption. This strategy enabled the hospital to: ➢ innovate in its investment decisions ➢ measure, analyse, assess and optimize the environmental and energetic impacts ➢ share and discuss about energy issues with suppliers and contractors The reductions between the end of 2012 and 2013 were: ➢ 10,74 % of the electricity consumption ➢ 14,43 % of water consumption ➢ 9,20 % of the fuel oil consumption The hospital owns the largest thermal solar installation of the island with about 280m² of solar cells on the roof. This saves about 25 $t_{éq}$ CO_2 per year. The production of domestic hot water thanks to solar energy amounts to 200 MWh/year. Besides, for a new building, the bioclimatic strategy made it possible to improve the energy performance by removing almost all the air conditioning units (except in technical and meeting rooms).
Relationship to STREAMER	Decrease in energy demand through technical solutions and conception
WP7 partner	APH

8.2.6 Nimes Regional University Healthcare District

TITLE	**Healthcare district : Nimes Regional University Healthcare District**
Reference	Environmental Approach Manual – tender stage (*CHRU Nimes – Cancerologie – Notice Environnementale.pdf*)
Status	Access limited to consortium partners
Language	French
Outline	Design & Build contract for the extension of the Nimes Regional University Healthcare District, specialized in Cancer Treatments
Relevance	Building under 2005 French Thermal Regulation (RT2005) – with an increased energy performance target (THPE) => reduction of at least 20% on energy consumption compared to the regulation.
Summary	This project is a new building of 19.500 sqm. under construction, in Nimes, in the south of France. It includes an efficient envelope, comprising external insulation behind an aluminium cladding, a concrete structure for a heavy thermal inertia, controlled external blinds to limit the solar heating in summer and thereby the cooling demand.

	Lighting Management to reduce consumption is installed, as well as DEL appliances in sanitary rooms. Due to all year cooling needs, a chiller equipped with heat recovery to pre-heat DHW is installed on the project. KPI – Ubat. The key performance indicator Ubat (W/m².K) highlights the quality and efficiency of the envelope of the bulding. For the project, regulatory calculations point out a gain of 33% compared to the reference indicator (Ubatref). KPI – Cep. The key performance indicator Cep (kWhep/m².year) highlights the primary energy consumption per sqm and year of 6 uses: heating, cooling, ventilation, domestic hot water (DHW), lighting and auxiliaries. For the project, the regulatory calculations point out a gain of 45% compared to the reference indicator (Cepref), with a value of 220 kWhep/m².year
Relationship to STREAMER	Energy efficient Building, passive and active materials/equipment to reach the objectives of energy consumption.
Additional comments	
WP7 partner	BOU

8.2.7 Toulouse Regional University Healthcare District – Purpan Site

TITLE	**Healthcare district : Toulouse Regional University Healthcare District**
Reference	Environmental Approach Manual – tender stage (*CHRU Toulouse – URM – Notice Environnementale.pdf*)
Status	Access limited to consortium partners
Language	French
Outline	Design & Build contract for the extension of the Toulouse Regional University Healthcare District on the Purpan Site, including the following healthcare units: ➢ Accident & Emergency ➢ Intensive Care ➢ Medical Care
Relevance	Building under 2005 French Thermal Regulation (RT2005) – with an increased energy performance target (THPE) => reduction of at least 20% on energy consumption compared to the regulation.
Summary	This project is a new building of 28.300 sqm. for 226 beds under construction, in Toulouse, located in the south of France.

	It includes an efficient envelope, comprising external insulation behind an terra cotta cladding. Metallic perforated vertical solar blinds for a good solar control with improved natural light. Roller blinds connected to the BMS for automatic control with the sun. Double-flow ventilation with heat recovery. Two systems are optional, in order to increase the energy efficiency of the project. First, a system Heliopac® to produce DHW from solar energy, through some black plastic solar panels, located on the terrace, combined with an electrical heat pump. For this project 200 m² of solar panels are able to cover 50% of the DHW needs, with a ROI around 9 years (according to the French price of energy eg. Gas and electricity). Then, the terrace-roof of the building can be used with photovoltaic panels to produce direct electricity and reduce the carbon footprint of the hospital, but without any energy reduction.
Relationship to STREAMER	Energy efficient Building, passive and active materials/equipment to reach the objectives of energy consumption, and carbon footprint.
Additional comments	
WP7 partner	BOU

8.2.8 Lille Regional University Healthcare District

TITLE	Healthcare district : Lille Regional University Healthcare District
Reference	Feasibility Studies on energy production systems – tender stage (*CHRU Lille – Etudes de faisabilité sur les productions énergétiques.pdf*)
Status	Access limited to consortium partners
Language	French
Outline	Design & Build contract for an extension of the Lille Regional University Healthcare District, including the following healthcare units : ➢ Addiction ➢ Psychiatry ➢ Gerontology
Relevance	Building under 2005 French Thermal Regulation (RT2005) – with an increased energy performance target (BBC) => reduction of at least 50% on energy consumption compared to the regulation.
Summary	This project is a new building of 6.900 sqm., in Lille, located in the north of France. To obtain the certification BBC (low energy consumption building), some innovative and efficient systems have been applied to the project as well as a passive design.

	It includes a high efficient envelope, with a thermal solar cladding with 250 sqm of solar collectors heating the fresh air beside a glass panel. The envelope of the building has a passive design, with an efficient compactness factor to reduce the heat losses, the south and west facades are highly glazed to increase the solar gain in winter season and to increase the natural lighting. North façade has low ratio of windows to minimize the heat losses. External insulation and concrete floor slabs increase the thermal mass and limit the losses. All bedrooms are equipped with external roller blinds. A system Heliopac® is installed to produce DHW from solar energy, through some black plastic solar panels, located on the terrace, combined with an electrical heat pump. The solar collectors are able to cover more than 50% of the DHW needs. To be able to reach the requirements of the BBC label, the heat production is realised with the district heating network, the solutions with gas or electrical heating have been studied but did not allow to reach the 50% gain on the Cep.
Relationship to STREAMER	Energy efficient Building, passive and active materials/equipment to reach the objectives of energy consumption.
Additional comments	
WP7 partner	BOU

8.2.9 Aulnay-sous-Bois General Hospital – Robert Ballanger

TITLE	**Healthcare district : Aulnay-sous-Bois General Hospital**
Reference	General presentation of the project – tender stage (*CHRU Lille – Etudes de faisabilité sur les productions énergétiques.pdf*)
Status	Access limited to consortium partners
Language	French
Outline	Design & Build contract for the refurbishment and restructuring of Aulnay-sous-Bois General Hospital (Robert Bellanger), with the construction of the following healthcare units : ➢ Mother child center ➢ Aftercare and rehabilitation (SSR) / Medicine Physical and Rehabilitation (MPR) ➢ Accident and Emergency ➢ Operating theatres
Relevance	Building under 2005 French Thermal Regulation (RT2005) – with an increased energy performance target (BBC) => reduction of at least 50% on energy consumption compared to the regulation.
Summary	This project is composed with several new buildings for a total of 26.900 sqm., in Aulnay-sous-Bois, located in the north north-east suburbs of Paris. To obtain the certification BBC (low energy consumption building), some

	innovative and efficient systems have been applied to the project as well as a passive design. It includes a high efficient envelope, with external thermal insulation. Glazing and windows frames are chosen to get an efficient envelope. The glazed surfaces have been determined to optimize the natural light potential, and to reduce the needs of artificial lighting during day time. Clear glazing associated to external sunscreens have been carried out to optimize natural daylight without too much solar gain in summer period. The air tightness of the envelope has been carefully studied to be able to reach the permeability of $1.2m^3$.hr per sqm of envelope. The fresh air is pre heated through heat recovery equipment on each air handling unit. High efficiency HVAC system, including low consumption fan coil units are chosen, and meeting rooms are ventilated with CO_2 sensors to adapt the airflow according to the occupancy of the rooms. Artificial lighting is controlled by occupancy and/or twilight sensors in common corridors. Dynamic thermal simulations have been realised to facilitate the choice of the systems for the cooling energy. Finally, thermal-chilled pumps mixed with traditional chillers have been chosen, both for energy efficiency and whole life cost.
Relationship to STREAMER	Energy efficient Building, passive and active materials/equipment to reach the objectives of energy consumption.
Additional comments	
WP7 partner	BOU

8.3 Energy efficiency current practices

8.3.1 Formalizing an energetic policy at healthcare district level:

The aim of the energy policy is to improve the knowledge of what the energy consumptions and the different uses (lighting, cooling, ventilation, etc.) are within an organisation in order to reduce them. Then, this makes it possible to:

- Clearly identify the different ways to save energy,
- Draw up a plan of prioritized actions with clear indicators and objectives
- Coordinate these actions.

This document, once validated and supported by the Direction, is then an important lever to involve the district in the energy efficiency.

Finally, the district should be able to precisely assess both the financial and the consumptions savings.

8.3.2 Ventilation

8.3.2.1 Air Handling Unit (AHU):

In some hospitals, these equipments operate 24/7 although some rooms, especially operating rooms, are not in service on week-ends or during the nights. Energy savings could be easily done either by stopping these installations or, at least, by using speed regulators in order to limit the electricity demands, during off hours.

8.3.2.2 Free cooling

The widespread use of free cooling for building limits energy demands since the outside temperature is used to cool down the building without operating air conditioning system.

8.3.3 Lighting

Some corridors, toilets or even offices can be lit up during the nights although nobody is present. Simple technical solutions can be implemented such as timers, light sensors, motion detectors, LED's, etc. to save energy quite easily.

8.3.4 IT

Similarly to lighting, it can happened that some computers, laptops or printers run all day and all night even on week-ends without any utility. The IT services of the hospital could consider shut downing automatically this equipment from a defined specific time (especially in the offices).

8.3.5 Maintenance

The targeted and efficient maintenance (especially with the use of computerized maintenance management system) can boost the quality/output of the installation / equipment (pipes, pumps, motors, filters, etc.) so that they can be in perfect working order.

8.3.6 Use of renewable energies

8.3.6.1 Biomass

The use of biomass can be considered when replacing a boiler for example in order to provide heating and hot water from wood.

8.3.6.2 Solar panels

DHW can be produced from solar energy, combined with electrical heat pumps. The solar collectors can be able to cover more than 50% of the DHW needs.

8.3.6.3 Photovoltaic panels

Terrace-roofs buildings for example can be used with photovoltaic panels to produce direct electricity.

8.4 Conclusions

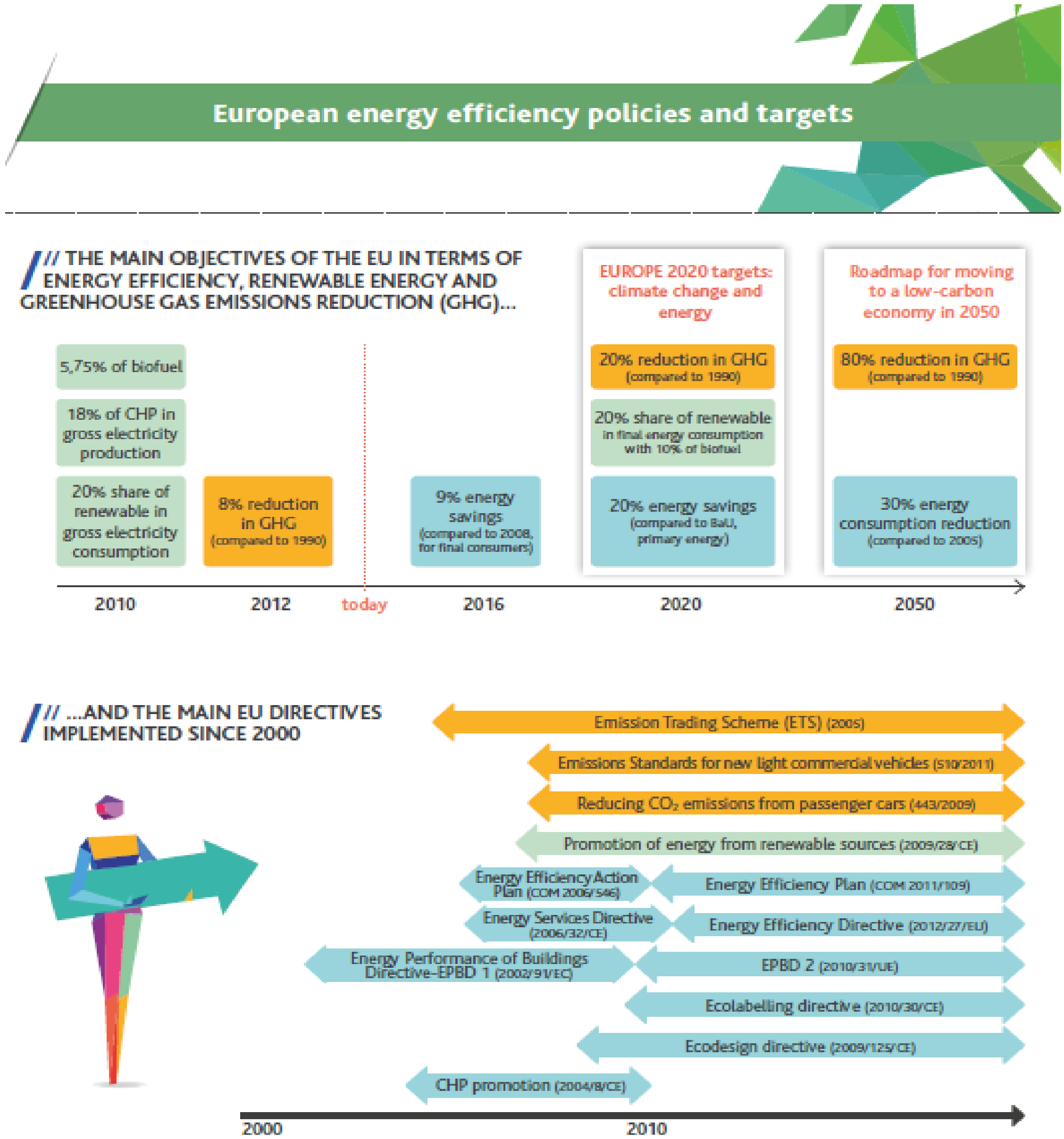
As mentioned above, energy topics are on the rise. Due to their important energy consumptions, hospitals have to be models for the society and have to show that they understand and share the current preoccupations of citizens. They have to be proactive on energy topics and not partisan of a wait-and-see policy. This inevitably requires the involvement at all levels of the hospital but especially the strong commitment of the Direction.

The shared reflections and cross-cultural perspectives between partners coming from different countries within the UE have to be the opportunity to open the discussions and the minds about the technologies or practices that are not implemented, to date, in a given country and to take advantage of everybody's experience and feedback. However, in order to solve any difficulties related to limitations, it is important that the recommended solutions have been tested so that they can prove in a very factual way the savings they can generate for an acceptable investment.

Participating to this project will also make it possible to have, for different topics, best practices methodological guidelines that we can follow for the refurbishments or the news constructions.

9. European, National and Local Legislation Related to Energy Efficiency in Hospitals

There are many pieces of legislation, including local, national and international regulations and targets that are relevant when addressing energy efficiency in hospitals. This section studies the legislations related to energy efficiency in hospitals and buildings in the previously studied countries, at European level, and worldwide.



9.1 United Kingdom

9.1.1 Part L of the Building Regulations 2002 (www.odpm.gov.uk)

It implements calculation methodology as a central part of demonstrating compliance. Essentially it has to be demonstrated that the annual CO2 emissions from the proposed building will not exceed a target level that is established by reference to the calculated emissions from a notional gas-heated building of the same size and shape as the proposed building. The notional building complies precisely with the minimum requirements of the 2002 Part L regulations and, to establish target emissions, an improvement factor is applied. That is, as well as implementing the EPBD the new regulations also raise the performance standards.

9.1.2 Standard Assessment Procedure (SAP)

In the UK, the Government's Standard Assessment Procedure for energy rating of dwellings was reviewed and extended so as to ensure compliance with the EU Directive 2002/91/EC and to enable its use for regulations and EPCs, leading to the current version known as SAP 2005 (www.bre.co.uk/sap2005). For non-domestic buildings and larger dwellings a new methodology has been developed, known as **Simplified Building Energy Model** (SBEM) (www.ncm.bre.co.uk). This is similar to the SAP based primarily on draft European Standards that are presently being written to support the EPBD.

9.1.3 The Carbon Reduction Commitment Energy Efficiency Scheme (CRC EES)

It is a UK Government scheme and is designed to improve energy efficiency and cut carbon dioxide (CO2) emissions in private and public sector organisations that are high energy users. The Environment Agency (EA) administers the scheme for the UK and regulates the scheme in England. Phase I ran from April 2010 to the end of March 2014 and Phase II is now running from April 2014 to March 2019. For each phase there is a qualification year, and in each compliance year an organisation is required to collate information about its energy supplies, submit a report about its energy supplies, buy and surrender allowances equal to the CO2 emissions it generated and keep records about its energy supplies and organisation in an Evidence Pack.

9.1.4 Display Energy Certificate (DEC)

It was introduced in the UK on the 1st October 2008 for public buildings over 500m2. The DEC must be displayed prominently at all times in A3 dimensions. The DEC was introduced by the UK Government in response to the EU Energy Performance of Buildings Directive. A DEC is designed to promote the improvement of the energy performance of a building and is based upon actual energy usage of a building and increase transparency about the energy efficiency of a public building. A DEC is rated A to G in a similar manner to the EPC and the penalty for failing to display a DEC is £500, with a further fine of £1,000 if there is no Advisory Report. In the future the Government is expected to extend the requirement of DECs to smaller public buildings over 250m^{2}.

9.1.5 The Quality, Innovation, Productivity & Presentation (QUIPP)

OUIPP collection is intended to be a resource for everyone in the NHS, public and social care for making decisions about patient care or the use of resources. Detailed information can be found at www.evidence.nhs.uk/qipp

Finally, we would like to mention that The Rotherham NHS Foundation Trust will commit to developing an Environmental Management System (EMS), in addition to the BREEAM Healthcare environmental certification scheme. There are a number of National Directives and Health Technical Memorandums (HTM) associated with energy efficiency and carbon reduction:

- HTM 07-02 – Sustainable Health & Social Care Buildings and Best Practices
- HTM 07-02 – (ENCO2de) Making Energy Work in Healthcare
- Saving Carbon : Improving Health – the NHS Carbon Reduction Strategy for England
- Government targets - Reduce carbon emissions by 80% by 2050 from Year 2000 baseline with a minimum reduction of 26% by 2020
- 35-55 GJ/100m3 for all new capital development or refurbishment, with existing facilities achieving a target of 55-65 GJ/100m3

9.2 Poland

9.2.1 Polish Energy Policy until 2030 (PEP2030)

As part of the environmental requirements set by the European Union for 2020 Poland has set quantitative targets so called "3x20% package", what covers:

- the reduction of greenhouse gas emissions by 20% compared to 1990,
- Reducing energy consumption by 20% compared to projections for the EU 2020.,
- Increasing the share of renewable energy to 20% of total consumption energy in the EU, including the increased use of renewable energy sources in transport to 10%.

In December 2008, has been adopted by the EU climate and energy package, which includes specific legal instruments implementation of the above. Policy through activities initiated at the national level in line with the policy objectives energy determined at European Community level. This document has been prepared in accordance with Polish Energy Law and presents the strategy of the state, with the aim to answer the most important challenges facing the Polish energy sector, both in the short term, and in the perspective of 2030.

9.2.2 National Action Plan for energy from renewable sources (KPD)

Document sets national targets for the share of energy from renewable sources consumed in transport, electricity, and heating and cooling in 2020, taking into account the impact of other policy instruments which have influence final consumption of energy as well as adequate actions which should be taken to achieve national overall energy targets for the share of renewable energy sources in final energy use.

The document also defines the cooperation between local, regional and national authority. Moreover gives guidelines how the estimated excess energy from renewable sources, could be transferred to other Member States and shows the strategy to develop existing biomass resources and mobilize new biomass resources for different uses.

9.3 Italy

9.3.1 National Energetic Programming-(L. n. 9/1991 & L. n 10/1991)

TITLE	National Energetic Programming-(L. n. 9/1991 & L. n 10/1991)
Reference	G.U. 16 January 1991, n. 13 http://efficienzaenergetica.acs.enea.it/
Status	Publicly available
Language	Italian
Outline	Rules for the implementation of the new national energetic program regarding the rational use of energy, the energy saving and renewable sources of energy development (l.n.10/1991). The l.n.9/1991 defines instead institutional aspects, hydroelectric station and power line, hydrocarbons and geothermal science, auto-production and fiscal disposals.
Relevance	It emerged as the result of the necessity for rationalization and reduction of the national energetic consume. These laws propose to regulate the thermo-technical sector. It is relevant as they are the first Italian laws that regulate the energy savings issues. It introduces the energetic certification, the technical report, limit in the energy consume for heating purpose, new considerations on buildings as systems of envelope and plants.
Summary	The main objective of this law is the improvement of the energy transformation in order to reduce the consumption of the primary energy and to improve the environmental compatibility conditions in its usage. Thus, the law focuses on the optimization of the existing resources, guaranteeing at the same time the environmental and thermal comfort. With optimizing the resources, the law means to improve the transformation process of the primary energetic vector. Thus, the rules present in this law support and incentivize, along with the energetic policy encouraged by the economic European Community to be applied in particular in the higher energy intensity sector (thus hospitals): ➢ the rational use of energy ➢ the limitation of the energy consume in the production and use of products ➢ the use of renewable sources of energy ➢ the reduction of the specific energy consume in the productive processes ➢ a more prompt replacement of plants This brings to a policy of energy savings, of appropriate use of the energy sources –ordinary ones included-, of improvement in technological processes that involve energy transformation, of development of the renewable sources of energy, of replacement of the import raw energetic materials. First of all, the law defines the renewable sources of energy: sun, wind, hydraulic energy, geothermal resources, tides, wave power, transformation of bio-waste, inorganic waste, plant products. In addition, cogeneration, heat deriving from thermal plants, sewage, etc., and energy deriving from productive processes and products (e.g. energy savings in lighting and air conditioning system)and from the savings achieved in cooling and lighting of buildings through interventions on the envelope and plants, can be assimilated to renewable sources of energy. The use of these energy sources is considered of public interest and utility. Consequently, the law issues the rules that define the general criteria for construction techniques and typologies for public buildings, including retrofitting interventions, according to the objectives expressed. The permits release and the funding provision are subject to these technical rules. Thus, the law forces the public administration to resort to renewable sources of energy and to operating through a thermal and electrical energy conservation policy within public buildings. In order to monitor the energy flow, this law introduces the role of the “Energy Manager”, who should be employed when the consumption of the public administration exceed a certain quantity. The “Energy Manager” identifies the actions, the interventions, the procedures, etc. that promotes the rational use of energy, and that ensure the provision of energetic balances depending on economic parameters and energetic uses.

	The law defines the typologies of intervention suitable to receive financial contributions. Among these, contributions up to the 80% are given to the interventions that provide for the photovoltaic system installation for the production of electricity. Moreover, contributions are foreseen for retrofitting interventions on the building envelope and installation systems, and for new development interventions that consider attentively the energy-related issues (e.g. use of renewable sources of energy). To summarize, the law aims to foster the development of the energy demand in terms of "eco-compatibility", appoints the savings on ordinary primary energetic resources as the primary resource. Moreover, it promoted the development of renewable sources of energy through incentives. The energy saving is considered here a renewable resource. All public and private buildings are subject to the rules defined with this law. The rules control the design phase, the implementation, the maintenance of the building, in addition to the components of the plants. In particular the energy consumption of buildings is limited by law, depending on the building use, the plants they are equipped with, the climate zone they belong to. Last but not list, the law provides for rules regarding the energy certification for buildings, identifying the condition that requires it and the subjects qualified for editing it. According to this law, some regions and territories such as the provinces of Trento and Bolzano operated a local program for the use of the renewable sources of energy that regulates the regional and territorial energy balance sheet, the identification of the regional energetic basins, the allocation and realization of the district heating plant, the identification of the financial resources to be addressed to the realization of new energy production plants, the destination of the financial resources according to priorities based on the energy saving, the definition of objectives according to the priority of intervention, the procedures for the identification and the allocation of the energy production plants, hydroelectric plants, etc.
Relationship to STREAMER	Despite that these laws have widely been overpassed by more modern regulations and their principles are nowadays taken for granted, it is relevant to the STREAMER aim in order to frame the Italian first steps regarding the topic of energy-efficiency. The concepts introduced in these two laws trace the concepts that still are in force and that STREAMER research project intends to integrate. The main difference lies in the means intended to be adopted in order to reach the objective of energy saving. On one hand, the Italian national energetic Programming proposes a set of incentives to stimulate and promote the rational use of energy. On the other hand, the SREAMER project aims to develop tools and design strategies that necessarily improve the energy use of buildings.
Additional comments	In years, many rules have been changed but many fundamentals are still in force.
WP7 partner	AOC/IAA

9.3.2 Thermal plants in buildings-(D.P.R. 412/1993)

Title	**Thermal plants in buildings-(D.P.R. 412/1993)**
Reference	G.U. 14 October 1993, n. 242 http://efficienzaenergetica.acs.enea.it/
Status	Publicly available
Language	Italian
Outline	Rules for the design, implementation, implementation and maintenance of the thermal plants in building. These rules are based on the objective of energy consumption containments in buildings
Relevance	This implementing decree is relevant as it provides the practical procedure and calculation to be adopted in the building design, implementation and maintenance for the application of the rules established by the law n. 10/1991.

Summary	The implementing decree DPR 412/1993 places the basis for the elaboration of the thermal need calculation necessary for a building-plant system, in accordance with the limits defined by the rules themselves in order to contain the primary energy consumption. The definitions given within the decree are crucial for the understanding of the energy policy development, thus they operate as a reference glossary. Among these: Thermal zone: the space within which the same temperature, the same use are maintained and the same plant operates Building: the space heated by the same plant Climate zone: already defined with the law n. 373/1976, these zones are divided according to the “degree days (d.d.)” on the national territory. Thus, the national territory is divided in six climate zones basing on the degree-days, independently from the geographical location. Zone A: municipality with degree days < 600 Zone B: municipality with degree days 600<d.d.<900 Zone C: municipality with degree days 900<d.d.<1400 Zone D: municipality with degree days 1400<d.d.<2100 Zone E: municipality with degree days 2100<d.d.<3000 Zone F: municipality with degree days > 3000. The D.P.R. 412 imposes the maximum temperature that can be reached inside the spaces. For this purpose, buildings are divided in different categories according to which they should meet the following parameters: 18°C+ 2°C for buildings belonging to category E.8 B) 20°C+ 2°C for buildings belonging to the other categories (including hospitals as they belong to category E.3 with outpatients clinics, rest homes and similar) Similarly, the heating period is fixed by law according to the climate zone the building belongs to (e.g. from 15/10 to 15/4) and the rules for the operation of the plants (e.g. intermittent, ten hours per day, etc.). Moreover, the law provides the calculation to be applied for the definition of the energy requirements, as the previous law did (L.n. 373/1976) on the whole seasonal cycle, considering the monthly medium temperature as reference. This calculation should take into account the plant in its whole (considering the typology, distribution, regulation) through its performance and the free supply provided by the sun (radiation) and the internal sources (e.g. lighting system, burners). These calculation procedures are foreseen according to the UNI standards, which provide formula, charts and diagrams for the elaboration of the calculation. Moreover, the DPR 412 provides for rules for the sizing, distribution, performance and maintenance of plants, still according to the UNI regulations In addition, the DPR 412 appoints the necessity for public building to use renewable sources of energy (e.g. solar, photovoltaic, cogeneration) or equivalent (heat pump, refrigeration units).
Relationship to STREAMER	The practical procedures developed within the implementing decree D.P.R. 412/1993 will turn out to be useful to the STREAMER scope in the process of validation of the STREAMER results on the demonstration cases chosen. Naturally, these rules play a role within the context of the Italian STREAMER case, AOUC-Careggi. Indeed, the D.P.R. 412/1993 lists procedures and calculation to be adopted in the building design, implementation and maintenance. All the data introduced by this law will be taken into consideration also for the energy simulation that STREAMER foresees for the Italian demonstration case.
Additional comments	In years, many rules have been changed but many fundamentals are still in force.

WP7 partner	AOC/IAA

9.3.3 Rules for the plants safety (Law n. 46/1990 and relative implementing decrees D.P.R 447/1991, D.P.R. 392/1994, D.P.R. 218/98, D.P.R. 558/1999)

TITLE	Rules for the plants safety (Law n. 46/1990 and relative implementing decrees D.P.R 447/1991, D.P.R. 392/1994, D.P.R. 218/98, D.P.R. 558/1999)
Reference	G.U. 12 March 1990, n. 59 G.U. 15 February 1992, n. 38 G.U. 18 June 1994, n. 141 G.U. 9 July 1998, n. 158 G.U. 21 November 2000, n. 272 **http://www.equaenergia.it/files/testoccord46-90-decr.pdf**
Status	Publicly available
Language	Italian
Outline	Rules for the plants' safety (l.n. 46/1990)and the relative Implementing decrees and later modifications still valid.
Relevance	The law n. 46/1990 and the relative implementing decrees are relevant as they define in details the intervention for which the elaboration of the design for plants is imperatively required. Moreover, they define who the subjects are allowed to install, transform, extend and maintain the plants.
Summary	All buildings addressed to civil use are subject to this law. The rules defined in this law involve plants for the production, distribution and use of the electricity, radio and television plants, heating and air conditioning plants, water and sanitary systems, fire protection plants and lifting systems. The implementing decree specifies that the healthcare buildings are subject to the law regarding the electrical system. First of all, the law defines who are the subjects qualified for the installation, transformation, extension and maintenance of plants, and the technical-professional requirements that these subjects should own to operate. The subjects owning the requirements are given a certificate that attests this. The beginning of the working activities should be declared before they start according to these laws. Then, the law focuses on the design of the installation systems. Within this law, it has been established that the elaboration of the design for the installation, transformation and extension of plants should be pursued by professionals with competence in that field. The implementation rules define the criteria and modality of elaboration of the design according to the complexity of the installation systems. The design reports should be deposited in the municipality office of competence. The design should include the plants diagrams and the plans drawings, in addition to technical reports regarding the quality, the installation, the transformation and the extension of the plant. The implementing decrees establish for which plants the design is imperatively required. As an example, the design is compulsory for electrical systems with used power major than 1.5 kW in case of spaces addressed to healthcare function. The installation of plants should be conducted according to the book. Materials and components should be realized according to the safety technical rules UNI

	and CEI, and within the respect of the technical legislation in force of this subject as well regarding the ventilation, aeration, disposal systems efficiency, sealing system, etc. When the implementation works are over, the installation company should declare the compliance of the plants realized to the rules established by the law through a report including the design drawings. The conformity of standards certificate is subject to the declaration of compliance of plants. This compliance can be conducted by the technical office of the companies, authorized for the pants design, when they are not in charge of the installation of plants. The compliance of plants certification is not necessary in case of ordinary maintenance interventions. The laws provides for penalties in case of violation of what established. The municipality and regions are compelled to adjust their regulation in order to meet the statement of this law.
Relationship to STREAMER	The law acquires relevance to STREAMER as it establishes for which plants the design is imperatively required. As an example, the design is compulsory for electrical systems with used power major than 1,5 kW in case of spaces addressed to healthcare function. Moreover, it is interesting as it presents the procedures to be followed not only for the design, but also for the implementation, transformation, extension and maintenance of the plants, which should be realized according to the safety technical rules UNI and CEI. According to this, the procedural aspects should be considered during the development of the process defined within STREAMER.
Additional comments	None
WP7 partner	AOC/IAA

9.3.4 Ministerial Circular (Ministry of Public Works) n° 13011/22.11.1974: Physical and technical requirements for healthcare buildings. Thermic, hygrometric, ventilating and lighting properties.

TITLE	**Ministerial Circular (Ministry of Public Works) n° 13011/22.11.1974: Physical and technical requirements for healthcare buildings. Thermic, hygrometric, ventilating and lighting properties.**
Reference	Ministerial Circular (Ministry of Public Works) n° 13011/22.11.1974
Status	Publicly available
Language	Italian
Outline	Physical and technical requirements for healthcare buildings.
Relevance	Minimum thermic, hygrometric, ventilating and lighting parameters for healthcare buildings.
Summary	The legislation defines the minimum values of thermic, hygrometric, ventilating and lighting parameters the healthcare buildings have to follow and the rules for measurement and audit. 1. THERMAL REQUIREMENTS OF THE ROOM: Transmittance of the opaque horizontal and vertical envelope. Transmittance of the transparent vertical envelope. Solar shading. 2. HYGROMETRIC AND VENTILATING REQUIREMENTS OF THE ROOM: Temperature and relative humidity. Ventilation of the room, ambient air change factor and air speed. Conditioning of the room. 3. INTERNAL LIGHTING: General requirements. Lighting level and luminance equilibrium. Daylight factor.
Relationship to STREAMER	Key Performance Indicators.
Additional comments	None
WP7 partner	AOC/IAA

9.3.5 Regulation (CE) n.761 of the 19th March 2001 related to the voluntary adoption of private and public organisations to a common Eco-Management and Audit Scheme (EMAS)

TITLE	Regulation (CE) n.761 of the 19th March 2001 related to the voluntary adoption of private and public organisations to a common Eco-Management and Audit Scheme (EMAS)
Reference	G.U. L. n. 114 of the 24.04.2001 http://ec.europa.eu/environment/emas/index_en.htm
Status	Publicly available
Language	Italian
Outline	Eco-Management and Audit Scheme (EMAS).
Relevance	The EU Eco-Management and Audit Scheme (EMAS) is a management instrument developed by the European Commission for companies and other organisations to evaluate, report, and improve their environmental performance.
Summary	Interest in the environmental performance of organisations is continually increasing. Operating without taking into account the environmental consequences of their actions becomes almost impossible for organisations. Organisations with a proactive approach to environmental challenges look for ways to continually improve their environmental performance. EMAS is the premium environmental management tool to achieve this. It leads to enhanced performance, credibility and transparency of registered organisations. Currently, more than 4,500 organisations and approximately 7,800 sites are EMAS registered. EMAS is a voluntary tool available for any kind of organisation aiming to: ▪ Improve its environmental and financial performance; ▪ Communicate its environmental achievements to stakeholders and society in general. **KEY ELEMENTS OF EMAS** PERFORMANCE: EMAS is a voluntary environmental management system based on a harmonised scheme throughout the EU. Its objective is to improve the environmental performance of organisations by having them commit to both evaluating and reducing their environmental impact and continuously improving their environmental performance. CREDIBILITY: The external and independent nature of the EMAS registration process (Competent Bodies, Accreditation/Licensing Bodies and environmental verifiers under the control of the EU Member States) ensures the credibility and reliability of the scheme, including both the actions taken by an organisation to continuously improve its environmental performance and the organisation's information to the public through the environmental statement. TRANSPARENCY: Providing publicly available information on an organisation's environmental performance is an important aspect of the scheme's objective. It is achieved externally through the environmental statement and within the organisation through the active involvement of employees in the implementation of the scheme. The EMAS logo which can be displayed on (inter alia) letterheads, adverts for products, activities and services is an attractive visual tool to demonstrate an organisation's commitment to improving its environmental performance and indicates the reliability of the information provided. In Italy, the EMAS registrations (Italian validation) are 1.036. The main sector

	is the public administration.
Relationship to STREAMER	Procedures. Environmental performance of hospitals.
Additional comments	The “e-hospital EMAS” is a project aimed to demonstrate that the use the EMAS regulation (No 761/2001) as a tool for developing environmental policies and action programmes in two hospitals in Athens and for establishing appropriate administrative structures.
WP7 partner	AOC/IAA

9.4 Sweden

9.4.1 Swedish building standards and energy requirements in the public sector

In Sweden, the building regulations are controlled by the Swedish National Board of Housing, Building and Planning, Boverket. The current Swedish building standards for premises are presented in Table 5. The building standard includes energy used for space heating, space cooling, and domestic hot water and operating electricity (excl. business-related electricity use). For climatic reasons, the building standard varies by climate zone; a higher energy use is allowed in premises located in the northern part of Sweden (120 kWh/m2, year) than if it is located in the southern part of Sweden (80 kWh/m2,year). Exceptions from these buildings standards can be made for different reasons, for instance if the air flow requirement is higher than 0.35 l/s and m2 (Boverket, 2014).

There is not yet a definition of near-zero energy buildings in Sweden, but more strict building standards have been suggested as a first step towards near zero in energy use in February 2015, see Table 5, which means even more strict energy building standard also for premises. Note that the Swedish building standard concerns the energy used in operation, not the energy use calculated.

Apart from the Swedish building standard, the municipalities often have more strict requirements on energy and environmental performance and the counties also have more ambitious targets related to these issues. The Swedish Government and Parliament have decide that public authorities should set an example when it comes to public procurements in order to stimulate the development of energy efficient products, but also to economise public funds (SCA, 2014).

Table 5 Current Swedish building standard for premises and proposed new standards after 1st February 2015 (Boverket, 2014)

	Climate zone I		Climate zone II		Climate zone III		Climate zone IV	
	Other heat supply kWh/m2	Electric heating kWh/m2	Other heat supply kWh/m2	Electric heating kWh/m2	Other heat supply kWh/m2	Electric heating kWh/m2	Other heat supply kWh/m2	Electric heating kWh/m2
Before 1 Feb 2015	120	95	100	75	80	55	80	55
After 1 Feb 2015	105	85	90	65	70	50	60	45

9.5 Netherlands

9.5.1 National Developments under the EU Directive on energy end-use efficiency and energy services and the 20% Energy Efficiency Target of the EU Public sector

Within Europe, the Netherlands are a frontrunner when it comes to sustainable procurement. It has been agreed upon by the government that in 2010 100% of central governmental procurement will take sustainability (including energy efficiency) criteria into account. For regional and local government, this percentage will be at least 50%. In the programme Sustainable Operational Management for Governments (DBO), criteria on sustainable procurement are developed and dissemination activities are carried out. The Dutch government will make agreements with local authorities to reduce carbon dioxide. These agreements will also contain sections on energy efficiency. The buildings of the national government will be climate neutral from 2012 on. This will be done by firstly increasing energy efficiency and the use of renewable energy. The remaining emissions will be compensated for. The exemplary role of the central government will also be undertaken by acting as “launching customer”. The government will apply innovative energy concepts in housing and mobility. Through its buying volume, the government can give a strong impetus to the development of innovative concepts, products and services.

9.5.2 Dutch legislation focused on the energy-efficiency of the residential sector

The positive development of energy-efficiency in this sector in the Netherlands is mainly due to legislation. Specific energy saving standards for in-house equipment and insulation standards for roofs, facades, windows and floors have been part of the National Building Decree for years now. In 1996 this decree has been expanded with a general Energy Performance Standard (EPN). This standard is based on a method to calculate the energy performance of buildings and express it in an Energy Performance Coefficient (EPC). In 1996 newly built dwellings had to have an EPC of less than 1.4. This standard has been strengthened several times since, and the maximum is now put at 0.8. Many of the other measures, such as the energy premiums are supportive to this decree.

Besides the National Building Decree, the Environmental Management Act is applicable to organisations as hospitals. Since 2007 this act includes an obligation to implement energy-saving measures with a cost-recovery period of five years or less. The Environmental Management Act will be substantially improved, for example by providing lists of specific approved measures.

Besides of the hard and fast laws and regulations, there are a lot of policies, guidelines and private initiatives to reach more energy-efficiency in hospitals.

9.5.3 The policy background to energy efficiency

The Dutch Green Building Council (DGBC) was founded in 2008 in The Netherlands as a market initiative. It is one of the first countries to adopt proactive policies and to implement measures to promote low energy buildings. These initiatives started in the 80’s, and have been significantly developed in the 90’s. In 1987, the policy on “sustainable” building became more institutionalized. In 1995, the Dutch government published an action plan on “sustainable” construction. It described the overall objectives and measures on green buildings i.e. standards on energy use, water consumption, and air quality. Sustainable building policies included different types of instruments and strategies, such as demonstration projects, mandatory policies, and alliances with industrial groups.

The new government that came into power in 2010 did not, unlike the government before, have a national target for energy efficiency. The former target was set for 2020, to achieve 2% annual savings on average from 2011 onwards. The policy for non-ETS sectors continued as before; a second National Energy Efficiency Action Plan as required by the Energy Services Directive was prepared in 2011. The new government lowered the targets for the share of renewable energy and the amount of greenhouse gas emissions to the level of EU targets. Although no national target was set for energy efficiency, the government still regarded energy efficiency important as a means to achieve the renewables and greenhouse gas emission targets.

9.5.4 Roadmap UMC's

Since 1992 the Dutch government is making multiyear agreements on energy-efficiency with companies and organisations. In 2011 the Dutch Federation of University medical centers (NFU) and the Ministry of the Interior and Kingdom relations have agreed on the energy saving of the Dutch academic hospitals. These eight large hospitals make efforts to be 30 percent more energy-efficient in 2020 than in 2005. In 2012 they have made a Roadmap UMC's how in 2030 the goal of 50% energy-saving in comparison to 2005 can be reached.

Overview policy measures for the residential/services sector

Measure title	Measure type	Semi-quantitative impact
Change the housing assessment system for social housing	Unknown	High
Sustainable building program	Co-operative Measures	Low
Energy Performance Standards (EPN)	Legislative/Normative	High
Energy Tax	Cross-cutting with sector-specific characteristics	Medium
EU-related: Recast Ecodesign Directive for Energy-related Products (Directive 2009/125/EC) - Energy labels on appliances	Legislative/Informative	Medium
Optimal energy infrastructure (OEI): 1997 onwards	Co-operative Measures	Low
MilieuCentraal, COEN (Consumer & Energy) and HIER campaign	Information/Education	Low
The Building Decree (2002 onwards)	Legislative/Normative	High
Compass - Energy-awareness in living and working	Information/Education	Medium
EU-related: Energy Performance of Buildings EPBD Recast (Directive 2010/31/EU) - Energy performance certificate for buildings	Legislative/Informative	Low
More with Less plan (Meer met Minder)	Co-operative Measures	High
Pilots energy saving for homeowners and private landlords in combination with district approach	Unknown	Low
Financial support homeowners	Financial	Medium
Covenant energy savings in newly produced buildings (Spring Agreement)	Co-operative Measures	Low
Covenant energy savings by housing corpora-tions	Co-operative Measures	High
Heat distribution law (warmtewet)	Legislative/Normative	Low

9.5.5 Energy Efficiency Policy measures Institutions and programmes

In the Clean and Efficient programme (Dutch: Schoon en Zuinig), introduced in 2007, the Dutch government set ambitious targets for 2020 for Greenhouse gas emission reduction (-30%), the share of renewables in the energy mix (20%) and the improvement in energy efficiency (increasing to 2,0% per year). The programme can be seen as an intensification of the existing multi-level policy approach. General cross-cutting measures such as energy taxation, fiscal measures such as the energy investment deduction and the European emission trading scheme form a general base for stimulating energy efficiency. Voluntary sectoral or sub-sectoral agreements were made with industries, services, major transport organisations and key players within the household sector. These agreements aim at a continuous improvement in efficiency. Energy efficiency standards have been introduced for most sectors to set a lower limit for efficiency. Innovators and frontrunners are (financially) supported.

9.5.6 Households and Services

Since 1995 the building Decree contains minimum standards for new buildings. They are based on a standardised method for the calculation of an Energy Performance Coefficient (EPC) which is related to the size of the building. The standards were strengthened multiple times, which led for example to a 50% energy efficiency gain for new dwellings since 1995. As part of the More with Less programme (Dutch: Meer met Minder), the government signed voluntary agreements with key players within the Dutch housing, energy and construction sector, to reduce energy consumption in existing buildings by 100 PJ in 2020. Reducing barriers for owners of buildings must stimulate them to invest in energy saving measures, which should lead to over 200.000 buildings being refurbished annually. The programme uses the recently introduced energy performance certificates for buildings (a result of the EPBD directive), to identify energy saving potential and monitor progress. The Energy Labelling for appliances has been introduced in 1996, and was originally combined with a national grant scheme. This led to a very high market share for some A-label appliances.

9.5.7 Environmental Platform Healthcare (MPZ): the Environmental Thermometer Healthcare

The Dutch Environmental Platform in the Healthcare (MPZ) is the trade association of hospital care settings for knowledge exchange and development for sustainable operations. Platform members are the majority of all university medical centers and hospitals, among other healthcare organizations. The association is active since 1994 and working on projects in the field of environmental management, environmental audits, monitoring of environmental performance and environmental costs and practical topics such as hazardous materials, water, energy, waste, waste water, transportation, purchasing, etc.

One of the projects of the association is the Environmental Thermometer Healthcare, a certifiable environmental management system that encourages and ensures a sustainable business. Dozens of healthcare institutions across the country are working with the Environmental Thermometer to improve the sustainability of their business operations. The first hospitals have achieved their certificate. It's a practical system that allows institutions to get on with it.

9.5.8 Limitation on the use of renewable energy sources caused by legislation

In the Netherlands building a wind turbine, applying solar thermal collectors, PV panels or heat and cold storage in the ground, extracting geothermal energy or combusting biomass, requires permits. Because of the spatial or environmental impact the use of renewable energy sources can have, a hospital has to deal with several laws and legislations, such as:

- Spatial Planning Act,
- Environmental Management Act,
- Environmental Impact Assessment,

- Acts that deal with the so-called duty of care,
- Pollution Act surface water,
- The new Mining Act,
- Dutch Emission Directive.

9.6 France

Energy is currently a global and strategic burning issue. As part of tackling climate change, European countries have implemented greenhouse gas (GHG) emission reduction objectives, and consequently, energy consumption reduction objectives. For example:

- renewable energy will have to represent 20% of EU energy consumption by 2020 (with different objectives depending on the country – 23% in France);
- all new buildings will have to be nearly zero- energy buildings by 31 December 2020 and after 31 December 2018, new buildings occupied and owned by public authorities will have to be nearly zero-energy buildings (DIRECTIVE 2010/31/UE);
- Energy consumption of existing buildings will have to decrease by 38% in 2020 (French law "LOI n° 2009-967, 3rd of August 2009";

The European requirements are then available in national regulations to take into account these objectives.

In France, the new buildings are now based on the thermal regulation named RT 2012, which aims to limit energy consumption. It corresponds to the application of a part of the commitments defined under the Grenelle 2 environment forum concerning better management of our energy consumption.

9.6.1 RT2012

The RT2012 is based on three main KPIs: A bioclimatic index, Bbio. This index defines the impact of bio-climatic design on building energy performance, and is independent of the energy equipment. It summarizes the needs of heating, cooling and artificial lighting. Therefore, it is the indicator of the design efficiency.
Bbio calculation = 2 x (Heating + Cooling need) + 5 x (artificial lighting needs), in kWh/m^2.year
The calculated Bbio must stay below a maximum index, based on the building use, with corrections according to the climatic location (7 regions in France), and the altitude.
For healthcare buildings, there are four types of use: day use building (or part of building), 24 hours use building (or part of building), with cooling authorised or not, according to the location of the building (near airport, highway…).

Bbio max / average	Without cooling rights	With cooling rights
24 hours healthcare building	230	270
Day use healthcare building	120	180

The 2nd KPI is a primary energy consumption index: The "Cep" index defines the building's primary energy use, for conventional use of heating, domestic hot water, cooling, lighting and auxiliaries, in kWh_{EP}/sqm.year. The Cep index for the building in question must be below a maximum value "Cepmax". The value of Cepmax is based on the building use (similar as the Bbio) with corrections according to the climatic location, the altitude and the GHG content of the heating/cooling system (for example a wood heating generation raised the Cepmax by 15%).

Cep max / average	Without cooling rights	With cooling rights
24 hours healthcare building	270	330
Day use healthcare building	130	190

The 3rd KPI is related to the summer thermal comfort: The "Tic" index is specific to the building. It defines the conventional interior temperature, which must be below a reference value "Ticref". This index is only relevant for the building without cooling rights.

Regarding the retrofitting of existing buildings, the current thermal regulation requires a reduction of consumption equal to the minimum between:

- -30% of the theoretical consumption of the current building
- The consumption obtained through calculation with reference information related to isolation, etc.

Furthermore, a draft bill (called “Energy transition for a green growth”) is currently being discussed at the French Senate (the draft was validated by the French National Assembly in October 2014). The main objectives of the law are:

- Reducing the primary energy consumption of fossil energies by 30% in 2030 compared to 2012
- Renewable energies will have to represent 23% of the final energy consumption in 2020 and 32% in 2030
- Realizing heavy works related to energy performance in the tertiary buildings and in the public-service buildings within 8 years as of January 1st, 2012. The objective here is to reduce the final energy consumption by 60% between 2010 and 2050.

Besides, an article of a French law imposes for private companies (including private hospital groups) which exceed some thresholds (number of employee, turnover) to publish and have verified, by an external third part, different CSR topics including a topic related to the energy consumption and measures to improve energy efficiency and better use of renewable energies which is a first step to transparency. This article will also be applicable for public organisms soon.

Finally, audits are also performed by the HAS (French Health Authority) and one section is related to energy management. Consequently, political and administrative leadership is an essential prerequisite for improving the energy efficiency of buildings.

9.7 European

The EU directive (2010/31/EU) on the energy performance of buildings implies that in the next few years all new buildings or existing buildings that are subject to major renovation have to be so called near-zero energy buildings. By December 31 2018 all new buildings occupied and owned by public authorities will be near-zero energy buildings and by Dec 31 2020, also all other new buildings will be near-zero energy buildings. Apart from having a very low energy use, a high share of the energy used in these buildings should come from renewable energy sources, including renewable energy sources on site or nearby.

9.7.1 The Building Performance Institute Europe (BPIE)

It provides a country by country review of the energy performance of buildings and the regulatory and legislative framework. Legislation includes:

- The Eco Design of the Energy Related Products Directive 09/125/EC a recast of Energy-Using Directive 32/2005/EC
- The End-Use Energy Efficiency and Energy Services Directive (ESD) 32/2006/EC
- The Energy Performance of Buildings Directive (EPBD) a recast of 2002/91/EC
- The Labelling Framework Directive 2010/30/EU a recast of 75/1992/EC

All the above aim to contribute significantly to realising the energy saving potential of the European Union’s building sector. The main legislative instrument in Europe is the 2002 Energy Performance in Buildings Directive and its 2010 recast. This is explained in greater detail below. Whilst most member states already had some form of minimum requirements for thermal performance of building envelopes before the introduction of EPBD, few had any prior requirements for certificates, inspections, training or renovation.

9.7.2 The European Union Energy Trading Scheme (EUETS)

It is the largest multi-country, multi-sector greenhouse gas emissions trading system in the world. It includes more than 11,000 power stations and industrial plants across the EU with around 1,000 of these being in the UK. The EUETS works as a cap and trade scheme so there is a “cap” or limit set on the total greenhouse gas emissions allowed by all participants covered by the system. This cap is converted into Tradable Emissions Allowances (TEA). One allowance gives the trader the right to emit 1 tonne of CO_2. Participants must monitor and report their emissions each year and surrender enough emission allowances to cover their annual emissions. If an organisation emits more than its allowance then it can buy more on the market. These are available because other organisations which have reduced their emissions can sell surplus allowances on the carbon market. Phase III of the scheme will run from 2013-2020.

9.7.3 The Energy Performance in Buildings Directive (EPBD)

It was set up in 2002 and the principal objective is to promote the improvement of the energy performance of buildings within the EU through cost effective measures. There are four main aspects to the EPBD:

- Member states must implement a methodology for calculation of the energy performance of buildings.
- There must be regulations that set minimum energy performance requirements for new buildings and for existing buildings when they are refurbished
- There must be an Energy Performance Certificate (EPC) made available whenever buildings are constructed, sold or rented out. The EPC will classify a building on a banded scale from A (best) to G (worst)
- There must be regulations that require inspections of boilers and heating systems and inspections of air conditioning systems. Boilers over 100 kW require an inspection every 2 years and air conditioning

systems over 12 kW output need to undergo a regular inspection every 5 years (TM44 inspection). These inspections are to ensure that systems are appropriately designed for the duty and size of the building.

9.8 Worldwide

9.8.1 The Building Research Establishment Environmental Assessment Methodology (BREEAM)

BREEAM is the longest established and most widely used method assessing in the world, rating and certifying the sustainability of buildings. Using independent licensed assessors BREEAM assess scientifically based criteria covering a range of issues in categories that evaluate energy and water use, health and well-being, pollution, transport, materials, waste, ecology and management processes. Buildings are rated and certified on a scale of PASS, GOOD, VERY GOOD, EXCELLENT and OUTSTANDING.

9.8.2 Building Codes

Building codes incorporating energy related requirements during the design or retrofit phase of a building is a key driver for implementing energy efficient measures, which in turn highlights the role of building energy codes in reducing CO_2 emissions. Energy code requirements and prescriptive criteria include performance based requirements for both new build and renovations such as building envelope thermal insulation requirements, e.g. roof, walls, floors, windows and doors (U values, V values etc.), air permeability, ventilation requirements, boiler and air conditioning efficiency and lighting efficiency.

10. Conferences and Research projects

This section includes the conferences, organisations, and research projects in the previously studied European countries, and at European level.

10.1 UK

10.1.1 Conferences

Several conferences and / or seminars in the UK deal with energy efficiency of buildings. Most are held on annual basis and they include:

- Sustainability Live 2015 www.sustainabilitylive.com is an annual exhibition and conference featuring displays, presentations, workshops and seminars for innovative energy and sustainability management
- The Energy Event 2015 www.theenergyevent.com is one of the UK's leading energy exhibition and conference events. It is the only energy event dedicated to energy management, efficiency and reduction
- The Energy Institute www.energyinst.org/events/conferences-seminar runs a series of conferences each year focussing on issues affecting the entire industry
- Ecobuild 2015 conference www.ecobuild.co.uk/content/conference is intended to explore good design of energy efficient buildings, and the designing of buildings so that they do not overheat, are energy efficient and comfortable and attractive to occupiers.
- The Energy Conference www.theenergyconference.com is a one day cost saving and energy efficiency conference aimed at driving behavioural change, pinpointing and reducing energy wastage, capitalising on technological innovations and making renewables viable.

10.1.2 Research projects

The Rotherham NHS Foundation Trust will commit to developing an Environmental Management System (EMS) in addition to the BREEAM Healthcare environmental certification scheme. There are a number of National Directives and Health Technical Memorandums (HTM) associated with energy efficiency and carbon reduction:

- HTM 07-02 – Sustainable Health & Social Care Buildings and Best Practices
- HTM 07-02 – (ENCO2de) Making Energy Work in Healthcare
- Saving Carbon : Improving Health – the NHS Carbon Reduction Strategy for England
- Government targets - Reduce carbon emissions by 80% by 2050 from Year 2000 baseline with a minimum reduction of 26% by 2020
- 35-55 GJ/100m3 for all new capital development or refurbishment, with existing facilities achieving a target of 55-65 GJ/100m3

There are several recent or current research projects being undertaken into building energy efficiency in the UK. These include:

- The UK Energy Demand Research Project (EDRP) www.ofgem.gov.uk/gas/energydemand-researchproject was a suite of large scale trials across Great Britain. The aim was to understand how consumers react to improved information about their energy consumption over the long term.
- The Energy Efficient Cities Initiative (EECi) www.eeci.com.ac.uk is a cross disciplinary research project at the University of Cambridge, aiming to strengthen the UK's capacity to address energy demand reduction and environmental impact on cities by research in buildings and transport technologies, district power systems and urban planning.
- Building Energy Efficiency Survey (BEES).
- The project www.gov.uk/non-domestic-buildings-energyuseproject is aims to improve and update evidence on how energy is used, and an assessment of the abatement opportunities for all non-domestic premises across England & Wales
- DECC Energy Efficiency Policy Research case study www.carbontrust.com/decc-energy-efficiency-policy-research DECC (Department for Energy & Climate Change) commissioned the Carbon Trust to conduct research exploring the design of policies to increase energy efficiency of electricity use within industrial and commercial sectors.

10.2 Italy

10.2.1 PhD Thesis, Giacomo Bizzarri

TITLE	PhD Thesis, Giacomo Bizzarri
Reference	Giacomo Bizzarri, PhD thesis, Energy analysis of hospital complexes
Status	Publicly available
Language	Italian
Outline	This work analyses and proposes solutions for energy efficiency in 24 hospitals.
Relevance	The relevance of this work is the use of BIM technology applied to energy saving.
Summary	The main objective of this research work is the definition of intervention strategies aimed at reducing energy consumption of operating rooms, the work examines the Italian laws but also International laws, and describes the various inspections carried out and the state of the art 24 hospitals. Once the main constraints that limit the possible interventions that can be applied to the facilities, a book of energy saving measures have been selected and tested simulating their effectiveness over the hospital digital models, previously built on specific software. Some solutions presented in the book are a passive retrofitting, based on increasing the thermal insulation of buildings and/or considering interventions on the external structures, replacement of single glazing with double glazing windows and the creation of green roof on the flat roofs. Then active retrofit actions are presented as well, mainly related to the application of cogenerators, plants fed by renewables, hybrid solutions assisted by high temperature solar systems and fuel cells, in order to improve the overall energy efficiency of the hospital system.
Relationship to STREAMER	Building information modelling.

Additional comments	*None*
WP7 partner	BEQ/AOC

10.2.2 Euro Energy Manager Project 0021/A2/M – Axis IV (within the European Initiative ADAPT II)

TITLE	“Euro Energy Manager” project 0021/A2/M – Axis IV (within the European Initiative ADAPT II
Reference	http://www.fire-italia.it/eell/ospedali/brochure/energia_sanit%C3%A0_lazio.pdf
Status	Completed
Language	Italian
Outline	The “Energy manager” project deals with the energy management in the healthcare sector in the Italian region Lazio. The aim is the formation and education of the “energy manager” profession with reference with the economic and technological changes.
Relevance	This project considers the clean technologies and the environmental conservation as a strategic factor for the enterprises choices and their competitiveness in the market. Its relevance is to consider the environmental variables as integral parts of the enterprise’s culture. Moreover, it contributes to the application of the Italian law n. 10/1991 that defines the role of the Energy manager.
Summary	The actions proposed are aimed to the contribution, information and awareness regarding the profession of the Energy Manger. The intervention has its objectives in the promotion of the Energy manager profession in the Italian regions, in the contribution of the occupational development inherent to the technological changes, especially regarding the environmental and resource conservations, in the contribution to the application of the Italian law n. 10/1991 regarding the topic of the Energy manager. The education and employment of the Energy manager profession in the energy and environment sector wants to be achieved through the information. Thus, the information deals with the evolutionary process and educational path and the professional qualification, the new professional profiles and the adjustment of the existing ones, the occupational prospective. Firstly, the study on the energy management of the healthcare sector in the region Lazio defines the actual situation of the existing healthcare buildings and gives information on the investment resources for the healthcare structures of the last years. According to these, a limited investment addressed to the technological innovation and improvement of energy management can be traced. Within the region Lazio, an analysis on the energy consume of hospitals has been conducted. According to this analysis, the allocation of the consumes can be hypothesized: 23% for electrical systems, 38% for heating and air conditioning, 14% for laundry services, 12% for the kitchen use, 11% for hot water, 2& for sterilization. According to these preliminary data, the project defines the energy management, which consists in the improvement of the energy efficiency of existing buildings and plants and in the application of the management processes addressed to a better use of energy. Indeed, the study states that a constant monitoring of consumes and performances is necessary, and the definition of the competences and responsibility regarding this issues within the company’s organization should be foreseen as well. The application of the energy management program requires a set of activities which should entail the quality of services and on the environmental impact within the respect of the economic and managerial requirements: • the preliminary energetic survey • the energetic diagnosis • the identification of the possible interventions • the compatibility assessment

	• the implementation of the intervention • the validation of performance in the maintenance phase The Energy manager is the actor that should implement the energy management program. The tasks for which he is engaged are the rationalization of the energy use, the operation and maintenance of the plants, the provision of the necessary supplies, the energetic accounting. The Energy manager is responsible for the identification of the actions, intervention, procedures, etc. necessary to achieve a rational use of energy, for the elaboration of energetic balance sheets according to the economic parameters and the final energetic uses, etc.
Relationship to STREAMER	The set of activities foreseen in the energetic management programme traces in part the activities that the STREAMER research project aims to develop, specifically in the validation of the STREAMER demonstration cases. Indeed, the preliminary energetic survey consists in the collection of the data regarding the energy consume, the analysis and the elaboration of the data collected, the calculation of defined “energetic indicators”, which is something STREAMER is already addressing. The evaluation of the compatibility of the intervention according of the physical characteristics, the financial availability, the law opportunities, etc. is the following activity to be developed. After the realization of the intervention, the monitoring and management of the maintenance phase should be foreseen.
Additional comments	The European initiative ADAPT deals with the “adjustment of the working force to the industrial changes”. It was aimed to the improvement the operation of the labour market. It could have a key role in supporting the growth, the occupation and the competitiveness of the enterprises through the development and formation of more qualified professional figures.
WP7 partner	AOC/IAA

10.2.3 European Programme JOULE – THERMIE: ACTION THERMIE B (STR – 946-96-IT)

TITLE	European Programme JOULE – THERMIE: ACTION THERMIE B (STR – 946-96-IT)
Reference	http://www.fire-italia.it/caricapagine.asp?target=eell/ospedali/FIREsanita1.htm
Status	Completed
Language	Italian
Outline	THERMIE B is a promotional campaign promoted through three meetings in Milano, Bari and Palermo, developed through a contract between FIRE, the Italian Federation for the rational use of Energy, and the European Commission in 1997.
Relevance	The project aims at the promotion of the "rational use of energy in Italian hospitals" through the information. Indeed, the results are presented in 5 brochures: the energy demand in Italian hospitals, the energetic accounting in hospital, and the financing for the energy efficiency intervention in hospitals operated by a third party, the Energy Manager role, and the air conditioning in hospitals.
Summary	The project is organized in four phases: the elaboration of six brochures that highlight European successful projects and experiences; three meetings (Milano, Bari, Palermo) for the information and spread of the European know-how; a period of assistance to the operators as a bridge between them and the European Commission and other information sources regarding the energetic technologies, the education and the financing; a day of study addressed to the evaluation of the results achieved and to the identification of strategies to be adopted in future interventions. It starts from the definition of the energy use in hospitals as it should meet crucial technological and functional requirements such as the lighting, the spaces air circulation, the laundry service, kitchen operation, hot water production, medical instruments sterilization, hospital garbage treatments, connection between spaces, cleaning service, diagnostic machinery operation, etc. The energy used can be classified in electrical, mechanical and thermal. All these typology of energy is required for the emergency route, thus interruption of the supply is not admissible. This is one of the reason why the energy consume in hospitals is so high. Some calculation confirmed that the energy use per person in hospitals is three times the one for housing. This consideration leads to a necessity of reducing the energy consumes in hospitals through innovation in technology and management. For this reason, an actor that manages these aspects is required. This actor could be represented either by the Energy manager and the Responsible for the operation and maintenance of plants. Firstly introduced by the law n. 10/1991 as the technician responsible for the conservation and the rational use of energy, the Energy manager is generally an employee of the hospital institution that has competence in the energetic and engineering field. The objective of its work is to analyse and control the energy consume and expenses, but could also be a management resources also for the healthcare policy operated by the regional administration. His task are defined by law and are the optimization of the supply contracts, the energetic accounting or the delegation for it, diagnosis and evaluation on buildings through monitoring, definition of a programme of interventions to be implemented for the improvement of the energy efficiency, definition of the budget required for the activities connected to his role. The accounting work requires the gathering of the data related to the total consumption, partial consumption and the evaluation of the needs. The accounting is necessary to define the energy efficiency. It provides for the collection and elaboration of the data related to the consumption of plants and the evaluation of the results incoming from the data. It is an essential tool for the definition of the possible intervention for rationalizing the energy use. In order to reach these objectives, equipment is needed for the measurements

	and monitoring: fixed instruments on the plants and mobile instruments to carry out surveys for the energetic assessment. The implementation of the energy efficiency intervention could be also operated through the financing operated by a third party. It could provide a solution as generally the interventions are limited due to difficulties in choosing the technological solutions, in defining a correct evaluation of the cost/benefits, in financing, in guaranteeing the performances of the solutions adopted. According to this kind of financing, the third party invest in the intervention, charging itself of all the intervention, operation and maintenance costs, returning its money in the long run proportionally to the gain achieved. ESCO (energy service companies) are here introduced as the economic and technical operator that could implement these kind of investments. The last brochure deals with the air conditioning issue defining the requirements, the regulation to be respected, the installation system solutions that can be provided and the aspects to be considered for the energy consume reduction.
Relationship to STREAMER	These brochures operate as informative readings and guide-lines regarding the rational use of energy in Italian Hospitals. It is interesting for STREAMER as it deals with all the crucial topics that will be further developed within the European research project. Among these, the description of the energy use in hospital is very important; in particular the analysis on how it should meet crucial technological and functional requirements without, at the same time, admitting an interruption of the supply.
Additional comments	None
WP7 partner	AOC/IAA

10.2.4 Workshop: "The "smart" use of energy in healthcare" 27 June 2008, Grosseto

TITLE	Workshop: "The "smart" use of energy in healthcare" 27 June 2008, Grosseto
Reference	http://www.fire-italia.it/eell/ospedali/Benchmarking.pdf http://www.fire-italia.it/eell/ospedali/Relazione_Grosseto.pdf
Status	Completed
Language	Italian
Outline	The workshop was held in Grosseto, on the 27th of June 2008, due to the organization of the AUSL9 "the local healthcare institutional body", who is very active in the development of strategies aimed to the smart use of energy in healthcare.
Relevance	This workshop day acquires importance as the topics considered are the results of a more than three-year work operated by the AUSL 9 Grosseto. The local healthcare institutional body of Grosseto activated a set of interventions on much healthcare structure present in that regional area, whose efficiency can be now measured.
Summary	The workshop deal with the organizational, technical and economic features to be considered in order to achieve a better use of energy within healthcare buildings. The motivation that lies behind the workshop is the assumption that hospitals are "energy-consuming" buildings and the possibility to reduce energy consume is limited due to the inherent necessity of equipment and comfort level. Considering this, the aim is to identify some strategies that would implement a set of interventions in order to achieve a smart use of energy in healthcare buildings. These interventions are aimed, on one hand, to promote different users' behaviours, to energy savings through the substitution of equipment and plants with more efficient ones, to improve the envelope technological solutions, to provide new sources of energy solutions, renewable ones where possible. The workshop is organized according to two main sessions, dealing with two different topics. It deals both with technical and non-technical aspects as the actors involved in the workshop are both technical experts and administrative and managements experts. "The business technical area, the rational use of energy sources, the Benchmarking as a measurement's tool" is the topic of the first session. One of the most interesting topics is the description of the results achieved in already implemented interventions (examples from Grosseto, Lazio and Emilia-Romagna are shown). Within this session, the topic of the Benchmarking as the measurement system to be applied is tackled. The starting point is the definition of the main causes of energy use inside hospitals. These can be divided in two main groups: the first group involves the "hotel-kind" consumes related to the patients and staff comfort. The consumes are active generally 8600 hours per years and involve the lighting system, the lifts, the summer and winter air conditioning, the ventilation of spaces, etc. These consumptions mainly depend on the climate conditions, the building and plants quality, the performance requirements, the demand-and-supply management quality. The second group involves the "equipment" consumes related to the diagnostic and treatment. They include the diagnostic tools, the air treatment for operating theatres and sterilization rooms. These consumes depend less on climate condition, but rather depend on the performance requirements and the demand-and-supply management of performances. The performance demand is increasing, entailing an increase in energy consume. This consume can be tackled, on one hand, through the

	technological improvement of buildings and plants and, on the other hand, through the improvement in the management of the performance demand and supply. The second session of the workshop deals instead with the new instruments for the energy conservation, the photovoltaic system and the new "Energy Bill".
Relationship to STREAMER	The aim of the workshop was to identify strategies that would implement a set of interventions in order to achieve a smart use of energy regarding technical, economic and organizational related issues. The approach followed in the development of the workshop would be very interesting for STREAMER as it starts from the identification of energy related issues and the assessment of them in order to gain a high level of knowledge of the Healthcare buildings operational use; which is the same approach the STREAMER project is based on.
Additional comments	The people intervening in the workshop are actors of the public administration involved in the healthcare, in particular in the AUSL 9 Grosseto, representative of the FIRE "Italian Federation for the rational use of energy", representative of the hospitals that operated energy-efficiency interventions, architects and engineer with competence in this field.
WP7 partner	AOC/IAA

10.2.5 Public Procurement of Energy Saving Technologies in Europe (PROST): Report on the Country Study for Italy

TITLE	Public Procurement of Energy Saving Technologies in Europe (PROST): Report on the Country Study for Italy
Reference	http://www.eceee.org/policy-areas/EEES/public_sector/ItalyPROST.pdf
Status	Completed
Language	English
Outline	The study was carried out from spring 2001 until late 2002 under the auspices of the European Union's SAVE programme.
Relevance	The study deals with energy efficiency in the (European) public sector as a whole, ranging from day-to-day product purchasing to building energy management and investments. Individual country studies were carried out within PROST. The countries involved are Austria, Belgium and Korea, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, The Netherlands, Poland, Slovakia, Sweden, Switzerland, UK, USA. The project operated as a framework for the European Commission, as it identifies the areas of major interest for future actions.
Summary	The project was originally conceived as a study on Public Procurement of Energy Saving Technologies in Europe, hence the acronym PROST. Although all the areas covered in the PROST report are subject to public procurement legislation, the study deals with energy efficiency in the (European) public sector as a whole, ranging from day-to-day product purchasing to building energy management and investments. The study was carried out from spring 2001 until late 2002 under the auspices of the European Union's SAVE programme. Individual country studies were carried out within PROST. The countries involved are Austria, Belgium and Korea, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, The Netherlands, Poland, Slovakia, Sweden, Switzerland, UK, USA. Regarding the Italian study, the project has been financed by the European Commission within the SAVE programme and by the Minister for the Environment and the Territory Safeguard. The project examined the modalities to lead he purchases of the public administrations towards solutions aimed to high energy efficiency. The project operated as a framework for the European Commission, as it identifies the areas of major interest for future actions. For instance, the topics for the definition of a possible Directive for the efficient supply in terms of energy in the public sector is are tackled. In addition the project proposes and defines the tools to be applied by the specific public organization such as purchasing specifications and minimum performances for the implementation and refurbishment of buildings. The report starts from the description of the national targets for energy efficiency and/or climate protection in the public sectors, including the trends and the expected evolution, and the national policy programmes on energy efficiency in the public administration. The focus is then the co-operative purchasing and energy management in the public administration, showing the energy plans and programmes. These requirements are born out of the 1988 National Energy Plan, which outlined the framework in which to develop national energy policy. With the principle objective of increasing national self-sufficiency the NEP identified the rational use of energy as the first of five strategic national objectives. The application of these requirements predates the concepts of sustainability formalized with Agenda 21 and subsequently the Kyoto reduction targets. Generally it can be said that the PA has failed to translate the potential offered by the requirements into effective measurable energy savings. Thus, all the law, regulations and guidelines for energy efficiency in the public sector are analysed (both regarding public buildings and public purchasing). Therefore, product purchasing, building investments and financial

	managements are treated, showing also success stories and good examples. The report ends up describing the Public Internal Performance Contracting (PICO), describing the usefulness and feasibility.
Relationship to STREAMER	The results of the reports for the Public Procurement of Energy Saving of Italy could provide useful information for the development of the task regarding the procurement procedures within the WP4 in STREAMER. Indeed, the project examined the modalities to lead the purchase of the public administration towards solutions aimed to high energy efficiency. Moreover, the project has a connection with the STREAMER project as it defines the tools to be applied by the specific public organization such as purchasing specifications ad minimum performances to be implemented.
Additional comments	eERG (end-use Energy Research Group) is the group of research on the efficiency in the end-use of energy. It is active from the 1996 within the Energy Department of the Politecnico of Milano.
WP7 partner	AOC/IAA

10.2.6 Project SA/3/94/I – 1995/1996 within the European Union program “SAVE”

TITLE	**Project SA/3/94/I – 1995/1996 within the European Union program “SAVE”**
Reference	http://www.fire-italia.it/pubblicazioni/sviluppo_energy_manager_nella_sanit%C3%A0.pdf
Status	Completed
Language	Italian
Outline	The study has been conducted between the 1995 and the 1996 by FIRE, the Italian federation for the rational use of energy. The study deals with the “development of the Energy Manager role in the healthcare sector”.
Relevance	The project is relevant as it defines precisely the activities the Energy Manager should be in charge of. Moreover, it proposes some organizational procedures that should be followed in order to clearly and definitely define the occupational position of the Energy Manager within the healthcare structure and administration.
Summary	The study defines the role and activities of the Energy manager in healthcare sector. The attention is given to the healthcare structure because of their high energy consume and application of technologies, thus because of the more complex role of the Energy Manager figure. As a result of a series meeting, the projects operated an analysis on the actual condition of the Energy Manager within the healthcare structure. The project starts from the assumption that there is a general lack of awareness regarding the energetic issues. It is thus stated that the role of the Energy Manager seems a simple application of the laws, more than an opportunity to promote a correct management of the energy consumes and costs. Organizational and procedural problems emerged. According to the problems observed, strategies and addresses to follow for the improvement of the efficiency and actions of the Energy Managers are identified. First of all, the project proposes some general organizational features that could be implemented, independently from the specific organizational and administrative structure of each healthcare organization. After defining how the assignment of the Energy Manager should be conducted, some operative procedures for the Energy Management are identified. These should be elaborated in a written text in order to be accessible and clear to everyone involved. In these, the relationships between the Energy Management and the other related functions such as services, contracts, purchasing, accounting, etc., should be described. Moreover, the procedures should contain the objectives and the energetic accounting methods, as well as the programme of activities the Energy Manager should respect, the internal budged and the available resources for the development of the Energy Management programme. Moreover, the project defines which the role of the Energy Manager is, and which are the activities is responsible for. Among these: • management, knowledge, verification, update of the Technical archive including building and plants drawings, certifications and authorizations, maintenance rules, etc.; • knowledge of the energetic condition through walk-around tour; • examination and evaluation of the supply contracts (electricity, heating, etc.) , and optimization of those when necessary; • identification of the possible intervention for the improvement of the energy consume; • analysis of the equipment and plants energetic characteristics; • energetic accounting; • analysis of the maintenance operations; • elaboration of a one-year programme of activities with the definition of

	the objectives, resources, means and actors involved; • elaboration of a budget proposal with indications on the costs of the activities and energy savings and energy costs reduction objectives; The project also defines the activities the Energy Manager should be subject to in order to update the professional competences.
Relationship to STREAMER	The study results to be interesting within the STREAMER scope as it identifies the tasks, procedures to be followed, roles and responsibilities of the stakeholders in charge of the energy aspects of healthcare buildings in the Italian context. The list of activities defined could provide suggestion for the development of the process and procedures related features
Additional comments	The project results and findings have been achieved through adequate working groups including Energy Mangers and specialists in this sector.
WP7 partner	AOC/IAA

10.2.7 Workshop: Energy Balance of healthcare districts

TITLE	Workshop: Energy Balance of healthcare districts
Reference	Provided by one of the organisers: Sante Mazzacane
Status	Completed
Language	Italian
Outline	The workshop was organized on the 25th of February in 2011 and dealt with the methodologies for the analysis of the thermal and electrical consume
Relevance	The analysis work developed within the workshop is relevant as it focuses on the thermal consumptions starting from the architectural characteristics of the healthcare buildings in terms of functional and typological aspects, in addition to the thermal needs both considering the winter and summer regime. At the same time, a similar analysis on the electric consume and needs has been pursued.
Summary	The workshop is organized as a one-day meeting in which the topics of the thermal and electrical consumes, the energy saving interventions and the state of the art regarding the energy certification of the healthcare buildings are tackled. The analysis of the thermal consumption starts from the analysis of the architectural characteristics of the healthcare buildings in terms of functional and typological aspects (e.g. data on functional areas square meters). Then, the thermal needs are assessed both considering the winter and summer regime. This analysis includes the assessment of the needs for the ventilation, transmission, humidification, hot water, natural gas, sterilization, etc. In addition, the methodology for the monitoring of the performances is presented. A similar analysis is conducted for the definition of the electrical consumes. It considers the electrical needs per year in a healthcare complex, the measurement of the refrigeration units consumes, the composition of the electrical consumes frames and the economic analysis of the costs. During the workshop, examples of possible intervention for the improvement of the energetic performances of healthcare district were presented. For instance, a proposal with all the possible interventions to be operated in the Hospital of Bologna was described. Among these, the thermal insulation coating, the use of condensation boiler, control of the Air Handler operational use, etc. A similar proposal is presented for an Hospital in the south of Italy, including the implementation of new refrigeration units, the optimization of the lighting use, etc. Therefore, this part of the workshop deals with the technologies for the production of the thermal and refrigeration energy, the supervising methods, the economic assessments, the composition of the possible interventions for the energy saving, and the evaluation of the incoming benefits. Last but not least, the workshop deals with the state of the art regarding the energetic certification of the healthcare buildings. In this part of the workshop the minimum performance requirements are described according to the law: energetic performance index, transmittance, condensation values, phase displacement and attenuation factor, glass solar factor, seasonal performances, etc.
Relationship to STREAMER	This workshop is relevant as all the topics tackled deals with the STREAMER scope and objectives. Indeed, it presents the methodologies for the analysis of the energy consume. The workshop presents the state of the art of the methodologies to be applied. These could be useful and valuable references for the definition of the role of the semantic model, which would be a sort of application of different methodology for the definition of the energy framework in healthcare districts.
Additional comments	The workshop has been conducted by Pasquale Romio, from the local healthcare institutional body of Bologna, and Sante Mazzacane, from the

	Architecture Department of the Ferrara University
WP7 partner	AOC/IAA

10.3 Poland

There are several conferences that are organised in Poland, related to energy efficiency in buildings, namely:

10.3.1 Budma - International Construction and Architecture Fair

(http://www.budma.pl/en/)

BUDMA's fair is usually attended by architects for whom a wide range of dedicated events have been prepared. Thanks to close cooperation with the Chamber of Architects of Poland (Izba Architektów RP), the project known as Architectural Forum is continued, where the debate "Mutual inspirations. European architects in Poland. Successes and failures" will be held and participated by foreign guests.

10.3.2 Hospital Build and Infrastructure

(http://www.hospitalbuildpoland.pl/en/)

It is targeted to health care industry executives, hospital architects, engineers, construction companies, medical technology and IT solutions providers. The covered topics that are:

- Design and architecture challenges with growing demand for "Healing Environment" and "Green Hospital" technologies.
- Efficient project management – success stories from Poland and abroad.
- How the latest technologies are being used to reduce operational costs and improve the quality of medical care?
- How important it is to gather the Experts of each professional area at one planning desk when designing advanced hybrid operating rooms?
- The background of making economic decisions about the introduction of unconventional building technologies.

10.3.3 Building Modernization Trade Fair

(http://targi.krakow.pl/gb/strona-glowna/targi/2-targi-modernizacji-budynkow/strona-glowna.html)

This conference is considered as an opportunity for companies and specialists that deal with energy efficiency with respect to the modernization techniques necessary for compliance with the rules of highly efficient passive construction; and for companies specialized in the supply of solutions for building management and for application in intelligent houses.

10.3.4 Warsaw Build 2015 International Building & Interiors Exhibition

(http://warsawbuild.pl/main/)

Warsaw Build is an international B2B building and interior exhibition in Central Poland, which gathers thousands of industry professionals from the building, interior and construction industries. It provides a unique platform for companies looking to enter and further develop in the Polish market, by offering invaluable opportunities to meet with industry specialists and present their company products to a targeted audience.

10.4 Sweden

10.4.1 Swedish Association of Local Authorities and Regions (SALAR)

Hospitals in Sweden are managed by the respective county councils or companies with close ties to the county council. Therefore energy issues in hospitals are always regional political issues. All of Sweden's 290 municipalities and its 20 county councils and regions are members in the Swedish Association of Local Authorities and Regions (SALAR). Every year, SALAR or SKL organises courses and conferences for their members and for politicians. The counties' property organisations also organise a conference and a study visit every year (SALAR, 2015). There are also forums for the counties' operational and maintenance staff, where they on a regularly basis meet and exchange experiences. Sweden is not larger than that good ideas spread among politicians and managers.

10.4.2 BELOK

BELOK is a co-operative project between the Swedish Energy Agency, the Swedish Construction Clients Forum and 15 of Sweden's largest local property owners, including property owners of premises for medical services. BELOK conducts various development projects in order to facilitate for energy efficiency measures and improvements of environmental performance. For instance, BELOK has developed a model called "Total Project" which implies that all energy saving measures on technical systems such as the ventilation, radiator and cooling systems are evaluated in one package solution instead of being evaluated individually. Measurement results show that decisions based on the Total Project model may half the use of electricity and heat and still be profitable for the property owner (SEA, 2011a).

10.4.3 UFOS Energy

UFOS Energy is a collaboration project between the organisation UFOS (for real estate managers of public buildings) and the Swedish Energy Agency. The projects and reports developed within UFOS Energy aim for improved energy-efficiency and reduced environmental impacts from property management (UFOS, 2015). For instance, they have published a report about how real estate managers can specify more strict requirements with regards to energy efficiency and how they can control the fulfilment of these requirements. Municipalities and counties can also apply for financial support to implement energy-efficiency measures (SCA, 2014).

10.5 France

10.5.1 Research projects

As part of the Regional Strategy Blueprint for Hospitals' Property (Greater Paris - Ile-de-France region), audits on hospitals' buildings have been realized for 59 healthcare facilities. These audits made it possible to collect a lot of information, especially regarding the energy performance of Greater Paris hospitals:

- General features of the building: surface area, building age, number of floors, etc.
- Building activities : number of beds, surface area per activity
- Building technical and regulatory assessment: heating/cold units, MEP, fire safety, etc.

- Energy profile of the sites: energy consumptions by source between 2010 and 2012 – electricity, gas, heat, domestic heating oil -, internal organization

(49 facilities filled in the energy questionnaire – 33 public hospitals, 11 private hospitals and 11 public facilities for mental health that represent more than 2,000,000 m²).

On the healthcare facilities sample and according to the hospitals'feedbacks, the average energy consumption between 2010 and 2012 amounted to:

- 500 kWhEP/m²/year (primary energy) or
- 314 kWhEF/ m²/year (final energy) - 118 kWhEF/ m²/year for electricity and 196 kWhEF/ m²/year for heating – and
- 70 MWhEP/bed/year or 44 kWhEF/bed/year
- The greenhouse gas emissions to: 53 kgeqCO2/m²/year et 7,400 keqCO2/bed/year

Based on the gathered information, a dynamic tool, dedicated to Greater Paris healthcare facilities, has been developed in order to:

- be an aid to decision-making to define strategies
- initiate the implementation of a "statistical observatory" making it possible to improve the knowledge about the buildings'energy performances and their evolutions over time
- rebuild the energy profile of each building according to its own features
- identify and prioritize the energy saving potentials for each building according to 3 classifications:
    - short time ROI (<10 years)
    - long time ROI (between 10 and 25 years)
    - very long time ROI (superior to 25 years)

The next step of this project will consist in formalizing and selecting the practical and concrete orientations regarding the energy transition policy for hospitals.

10.5.2 Conferences on energy efficiency

On March, 25th and 26th, an international conference on the BIM, the BIM World 2015, will take place in La Defense (near Paris). This event will be the opportunity to review the situation about the digital use when building a new building or retrofitting old one. Different workshops will be organized during these two days according to three topics: technology, strategy and achievement.

http://www.bim-w.com/?lang=fr

http://www.bim-france.fr/evenement/bim-world-2015/

10.6 European

10.6.1 GREEN@Hospital

TITLE	Green@Hospital
Reference	http://www.Green@Hospital-project.eu/

Status	In progress
Language	English
Outline	Green@Hospital is a three-year European Project research that started in February 2012 and will end in February 2015. The aim of this research is to develop an energy management and control system to improve the energy performance of hospitals and other public buildings. The research is carried out by a consortium of eleven partners from different field. There are technological partners, research centres and Pilot Hospitals.
Relevance	The Green@Hospital project aims at integrating the latest ICT solutions in order to obtain a significant energy saving in existing hospital buildings, through a better management of energy resources and losses reduction. An important aspect is that the solutions developed are validated and tested in four pilot hospitals considering their real operating condition. According to the results obtained, the study wants to operate as basis for possible replication of the solutions.
Summary	Green@Hospital research was grounded in the growing necessity to achieve real energy savings from existing building stocks and to build more sustainable new hospitals. Hospitals are taken as the research subject of analysis for their being large energy consumers in most European countries and, at the same time, the less efficient public buildings. The objective is to create web-based energy management system for the optimization of the energy consumption in hospital. Green@Hospital acts on ICT devices and infrastructure converting them from energy intensive systems to drivers for energy efficiency. The research project expects to achieve 15% consumption in the heating and cooling generation, lighting, ventilation, data centre systems. It will result in a Web-based Energy Management and Control System (Web-EMCS) which integrates model based energy savings algorithms. Moreover, a Maintenance Energy Service will be provided in order to help in the maintenance optimal energy efficiency after the initial efforts. It will integrate, monitor and control multiple buildings systems at the component level. Indeed, Green@Hospital aims at optimizing the energy use in hospitals not considering the building in itself in terms of geometry and physical characterization. The solutions developed are validated in four pilot hospitals considering their real operating condition: General Hospital Chania Saint George in Crete, Ospedali riuniti di Ancona in Italy, Fundacio Sanitaria de Mollet and Servicio Andaluz de Salud both in Spain. These hospitals have been selected considering the presence of advanced technological solutions for energy efficiency and the geographic and cultural background. Each hospital will make available specific areas selected considering the presence of: 1) renewable energy sources, 2) already available building management systems that can be easily integrated in the Web-EMCS, 3) refurbishing plans aiming at energy efficiency improvement. The study will be the basis for possible replications of the solutions taking into account savings and return of investments. First of all, the research developed a standard benchmarking model for energy measurement in hospital environment despite the local climate condition of each hospital, which of course, affects the energy use. However, hospital energy use also varies according to specific factors such as type of patient, type and length of treatment, use of specific medical equipment, availability (or not) of energy intense services such as laundry or kitchen, etc. Most of the energy systems in large buildings such as hospitals include specific control systems. These control systems are independent from each other, and therefore, a holistic control strategy for all of them cannot be implemented. The second objective of the Green@Hospital project is to develop an Energy Management and Control System (EMCS) to integrate the solution sets and monitor the results achieved. The third main objective of the project is to develop a holistic control strategy that can potentially reduce the overall energy use by seeking synergies among the energy systems. This will result in the elaboration of advanced algorithms.

	Green@Hospital has created a web based platform able to communicate with the four pilot hospitals and to manage the different solution sets. The platform shows the information concerning the energy savings achieved through the application of nine energy solution sets, observed through monitoring. Taking the Ospedali Riuniti di Ancona as example, eleven rooms have been monitored to test the energy saved, the CO2 saved, money saved, ant the comfort level. The energy savings strategy has been elaborated on two sides so far: lighting and data centre system. Generally, the lighting system accounts for the 16% of the energy consumption of a typical hospital. The general idea is to control artificial lights in order is to guarantee comfort conditions avoiding energy wastes. The creation of an ICT infrastructure permits to host energy saving strategies based on presence detection, luminance level optimization and time schedule based control. The choice of LED lights guarantees not only an improved efficiency due to an higher lux – watt ratio but allows implementing control strategies without decreasing light source lifetime as it would happen with fluorescent lamps. Data Centre loads are increasing due to digital medical equipment and data management needs. Furthermore, it requires energy not only for computational needs but also for cooling and other auxiliary loads. These solution sets aim at reducing the energy consumption needed for data centre cooling. The PUE (Power Usage Effectiveness) is the KPI chosen to evaluate the data centre performance. In Ospedali RIuniti di Ancona savings are obtained predicting external air temperature and IT load, regulating dry-cooler fans and pumps speed and exploiting a thermal storage. The free-cooling system activates with a wider range of external temperatures, operating on system management and avoiding new hardware installation.
Relationship to STREAMER	Green@Hospital and STREAMER have obvious similarities regarding both the subject of the research and its objectives. The main difference consists in the fact that Green@Hospital aims at energy savings acting on the component level, thus on the mere plants level; whereas STREAMER aims at energy savings considering the hospital in its whole, thus according to its physical and geometrical characteristics. Anyway, GREENHopsital analysis could result crucial and useful especially regarding the operational management developed in the standard benchmarking model for energy measurement in hospital environment (type of patients, type and length of treatment, use of specific medical equipment, availability of energy intense services such as laundry, kitchen, etc.). This benchmarking model will help STREAMER to define, on one side, the parameters that build the BIM model and, on the other side, the KPI to be kept under control during the design and operational phase.
Additional comments	The research will be completed in February 2015, thus concrete findings can be found soon.
WP7 partner	AOC/IAA

10.6.2 The European Centre for Health Assets and Architecture (ECHAA) Policy Seminars

ECHAA is a partnership to support and promote evidence-based policy decisions related to the built environment of the health sector. ECHAA has a commitment to working for the healthcare sector, using European and other regions' experience, and uniting academic and practical expertise. More information about ECHAA can be found on the website: www.echaa.eu.

The purpose of the seminars is, by means of comprehensive and rigorous analysis, to support and promote evidence-based policy decisions on the contribution of the built environment to the European health sector. The focus of the Centre is on long-term issues of sustainability and appropriateness of the estate – service planning, architecture/design, finance, construction and operation of hospitals and other healthcare facilities. The Centre's bi-annual series of Policy Seminars is designed to generate and disseminate understanding about topical and policy-relevant health and healthcare issues, especially those linked to the estate and to capital investment. ECHAA's belief is that there is a strong and unmet demand for new knowledge generation and transfer is this area.

10.6.3 European Health Property Network (EuHPN)

EuHPN is a network of European governmental and research organisations responsible for the strategic asset planning and management of all form of health property, from hospitals to health centres. The network was established in 2000 in the Netherlands as a non-profit trust for the purpose of promoting excellence in health property provision and management. EuHPN member organisations share information about health buildings through an annual workshop, regular seminars and personal networking.

10.6.4 RES – Hospitals

TITLE	RES-Hospitals
Reference	**http://www.res-hospitals.eu/**
Status	Public
Language	English
Outline	RES-Hospitals is a research project during 30 months sponsored by the Intelligent Energy Europe programme (2011-2013) conducted by a consortium of five European countries.
Relevance	One of the main outputs of this research is the elaboration and the publication of a "Renewable Energy Guide for European Hospitals", which considers the main factors that influence energy use in hospitals. It is a non-technical document to be addressed to hospital directors and health agency stakeholders in order to increase awarness and understanding of the strategic business case for investment in the renewable energy system.
Summary	RES- Hospital project aimed to provide supports to hospital to be more strategic and sustainable in order to reduce the energy consume and production through the exploitation of renewable energy system. The project focused in particular on the identification and promotion of good practice, as well as the study of pilot projects. It included 18 hospitals in seven countries (Spain, Italy, Netherlands, Poland, France, Hungary, UK) on which an extensive research, consultations and workshop has been made in order to understand the wider European context and gather case study evidence. It resulted in the elaboration of the "Renewable Energy Guide for European

	Hospitals", individual pilot project report for the 18 hospitals, an "Impact Assessment" report of the national pilot project, two newsletters that summarize the peer learning workshops, which were held in different countries. The "Renewable Energy Guide for European Hospitals" aims to provide knowledge to the ones responsible for reducing energy costs, minimising future energy risks and ensuring the environmental sustainability of the hospital(s). It first analyses the main factors influencing the production of energy renewable energy in hospitals, highlighting thus the different feasible options between the different hospitals according to their geographical location, possible fiscal incentives, regulations, electricity/gas markets and supply chains. The Guide illustrates possible solution to the main non-technical barriers identified for financial, cultural, institutional, need policy intervention according to the country considered. Moreover, it provides a set of feasible options to be adopted. In the final section, it deals with the business case for investment. The hospitals have been taken into analysis to explore options to achieve a zero carbon hospital in the future and develop an investment plan for 50% of energy consumption from renewable energy by 2020. The individual pilot project report shows the solutions that could be adopted to reach the goals. All the participating hospitals achieved in identifying technically feasible options for 50% RES with the most popular solution based on biomass. Some explored more radical options such as deep geothermal systems and community energy projects. Others looked at combinations of different technologies, a mix of on-site production and partnership with off-site developers and/or opportunities to take advantage of renewable energy production by utilities. In most cases, the economic situation in Europe has made the challenge of securing funding for the 2020 investment plans more difficult but some have already been successful. The individual pilot project report for each hospital contains the general description of the Measurements, Monitoring and Reporting System, the current energy situation in terms of energy use, RES share, the CO2 emissions, the description of the energy efficiency measures both already implemented and the possible ones for further energy savings, the description of renewable energy measures already implemented and the planned RES investments, the potential impact of the pilot project according to the energy savings measures and the energy generation via RES, the Zero Carbon Roadmap and the recommended actions towards 2020. Seven Peer workshops were organized to give the participants and other influential stakeholders to learn from each other and to observe good practice in different countries and hospitals.
Relationship to STREAMER	RES-Hospital project is relevant to STREAMER research project as it provides practical information regarding the energy measures and actions to be planned and implemented in hospitals in order to achieve a substantial reduction of energy consumption. Moreover, the factors and parameters identified to verify the current energy situation of hospitals could be helpful for the elaboration of the parameter and factors that should be taken into account for the STREAMER objectives.
Additional comments	The pilot project carried out by the consortium was 15 in four countries (five from Spain, four from Italy, three from Netherlands and three from Poland). The left three pilot projects (France, Hungary, UK) participated through the voluntary involvement of health sector organizations that joined the consortium using their own resources.
WP7 partner	AOC/IAA

RES-Hospitals aimed to reduce energy consumption of the existing stock of 15,000 hospitals in Europe and increase their energy self-sufficiency through renewable energy sources, thus supporting the EU2020 Energy targets. The sector has a relatively high energy-intensity and collectively accounts for some 5% of Europe's CO2 emissions.

The barriers to reducing energy consumption and investing in renewable energy systems (RES) in hospitals were explored through pilot projects in eight European countries. Best practice case studies and lessons from the pilots were disseminated widely to hospital decision makers through events and a 'RES Guide for European Hospitals'.

RES-Hospitals project was led by the Asti Local Health Agency in Italy and included partners and associates from seven other countries as well as a European network (http://www.res-hospitals.eu/). More information on RES-Hospitals demonstration cases:

http://www.reshospitals.eu/LinkClick.aspx?fileticket=kM7aVw3sPJE%3D

10.6.5 HosPilot

Cost-effective energy savings in healthcare buildings- A decision support software tool for hospital managers: getting the best advice for newly built and refurbishing hospital (http://hospilot.eu/). With advanced capabilities embedded, while at the same time easy to use, the HosPilot Tool is designed for the technical advisor or facility manager of a hospital. The essence of HosPilot is to capture the expertise of Lighting and HVAC consultants to provide decision support for energy efficiency refurbishing strategies.

10.6.6 LCB-Healthcare: Procuring better building solutions.

(http://lowcarbon-healthcare.eu/main/).

LCB-Healthcare stimulates demand for innovative low-carbon solutions for the healthcare sector by providing procurement decision makers with the knowledge and tools to achieve more sustainable buildings within their budget constraints.

11. Foreign Guidelines

In this section, we briefly describe two well-known international guidelines and standards for energy efficiency in hospitals, namely: the German DIN 1946/87 and the American ASHRAE standard.

11.1 DIN 1946/87 Germany

TITLE	DIN 1946/87 Germany
Reference	http://www.bht.ch/ http://www.inoutic.de
Status	Publicly available
Language	English/German
Outline	The standards focus on the ventilation and air conditioning. Part 4 deals with ventilation in hospitals.

Relevance	DIN 1946 is relevant as it operates as a guideline for the design, construction, operation and monitoring of ventilation and air conditioning systems in hospitals.
Summary	The DIN Standard has been subject to many reviews since 1987. Since 2009 the DIN 1946-6 stipulates that all new building must have ventilation concept. In renovation project a ventilation concept also has to be provided for certain building typology. The fresh air supply to living areas and buildings is a topic that is steadily gaining importance, particularly in view of the modern, energy-efficient construction methods used today. An updated version of the ventilation standard DIN 1946-6 was therefore published after a lengthy revision phase. The goals of the ventilation standards focus on the following key points: • Definition of limits and calculation methods for the necessary minimum air exchange rate requirements. • Definition of a verification method (ventilation concept) to determine whether a ventilation measure is necessary for a building or not. • The ventilation concept is also to be used to determine how the ventilation measure is to be implemented: manually by the residents or with the aid of a ventilation system. The DIN 1946-6 foresees four different ventilation levels: ventilation for moisture proofing, reduced ventilation, nominal, intense ventilation. The level of insulation and the location of the building are also included in the calculation basics for the ventilation levels acc. DIN 1946-6. In addition, the new DIN 1946-6 provides the designer with legal certainty in decisive issues. Some issues, however, have still been omitted.
Relationship to STREAMER	Ventilation performance requirements
Additional comments	None
WP7 partner	AOC/IAA

11.2 ASHRAE Standards and ASHRAE Handbooks America

TITLE	ASHRAE Standards and ASHRAE Handbooks America
Reference	www.ashrae.org
Status	Publicly available
Language	English
Outline	ASHRAE (American Society of Heating, Refrigerating and Air conditioning Engineers) is a building technology society founded in 1894. Its work concerns research and technology focusing on building systems, energy efficiency, indoor air quality, refrigeration and sustainability. The society counts more than 54 thousands members worldwide.
Relevance	The work developed within ASHRAE acquires relevance as it develops well-recognized series of standards and guidelines related to the HVAC systems and related issues. Despite that these standards are legally unenforceable, they are often referenced in building codes and are commonly accepted by architects and engineers.
Summary	ASHRAE (American Society of Heating, Refrigerating and Air conditioning Engineers) is a building technology society founded in 1894 focusing on building systems, energy efficiency, indoor air quality, refrigeration and sustainability. ASHRAE develops series of standards and guidelines related to the HVAC systems and related issues. These standards, legally unenforceable, are often referenced in building codes and are commonly accepted by architects and engineers. All these standards are periodically reviewed and re-published in case of changes. The standards focus on Method of Measurements or Test, Standard Design and Standard Practice. Among these standards: Designation and Safety Classification of Refrigerants, Thermal Environmental Conditions for Human Occupancy, Ventilation for acceptable Indoor Air Quality, Standards for the Design of High Performance Green Building, etc. ASHRAE writes standards for the purpose of establishing consensus for methods of test for use in commerce and performance criteria for use as facilitators with which to guide the industry. The ASHRAE Handbook is a four-volume publication. it is considered the practical repository of knowledge on the various topics that form the field of heating, ventilation, air-conditioning and refrigeration. The four volumes are Fundamentals, Refrigeration, HVAC Applications and HVAC Systems and Equipment. ASHRAE is currently working on making “Advanced Design Guides for 50% Savings”, which offer designers and contractors the tools needed for achieving a 50% energy savings. Therefore, these provide recommendations for achieving energy savings over the minimum code requirements of ASHARE standards and other ones (ANSI and IESNA). Each of these addresses a specific building type. Indeed, an Advanced Energy Design Guide for Large Hospitals has been developed with the collaboration of the U.S. Green Building Council and the U.S Department of Energy. The recommendations in the Guides allow those involved in designing or constructing large hospitals to easily achieve advanced levels of energy savings without having to resort to detailed calculations or analyses. The prescriptive energy-saving recommendations are contained in a single table for each of the eight U.S. climate zones. Help in implementing the recommendations of the Guides can be found in an expanded section of how-to tips in the "How to Implement Recommendations" chapter. The how-to information is cross referenced with numbered tips and color-coded climate zone maps. Examples of advanced building designs and technologies are also provided to illustrate the points made and to demonstrate the flexibility offered in achieving the advanced energy savings

	provided within the Guides.
Relationship to STREAMER	The ASHRAE work could operate as a good reference for STREAMER, in particular the Advanced Energy Design Guide for Large Hospital. Indeed, the guide aims to achieve 50% energy savings in healthcare buildings through recommendations and strategies for integrated design. The similarity between this guide and the broader objective of STREAMER could be traced in the European research description which states: “Optimized design methodologies for energy-efficient buildings integrated in the neighbourhood energy system”. Therefore, the guide identifies a clear prescriptive path to 50% energy savings proposing set of recommendations and how-to-tips. Indeed, it takes into account energy-related topics and issue that cover the whole building system and its life-cycle performances. Considering this, the guide could help the STREAMER European project in defining design guidelines, crucial parameters for analysis, KPIs and other topics relevant to the STREAMER scope.
Additional comments	The ASHRAE work is subject to a continuous and attentive review and refinement, which lead to updated publication of new results.
WP7 partner	AOC/IAA

12. **Conclusions**

There is no doubt that healthcare centres are high energy consumers, which explains the previous, current, and future inversions in projects, regulations, and improvements to reduce the energy consumption and increase the efficiency in healthcare centres. This is why governments, states, and regions shall approve, enforce, and regularly update the requirements for energy efficiency in buildings in general, and specifically in healthcare buildings, by building codes and best practices guidelines.

In this document, we have surveyed the list of healthcare centres, who have implemented energy efficiency measures, in six European countries, namely: UK, Italy, Poland, Sweden, Netherland, and France. For each of these countries, the current practices, equipment, and technologies for energy efficiency in buildings were also surveyed. Furthermore, we surveyed the current regulations and codes related to energy efficiency in buildings in the European countries, and some foreign guidelines for energy efficiency in buildings. Our conclusions are detailed in the following in this section.

Regarding the healthcare centres who have implemented energy efficiency measures, we can notice that a high number of centres in Europe have already carried out some refurbishment to adapt to the existing and recently approved laws on energy efficiency, to reduce energy consumption using latest technologies, and to reduce the CO2 emissions. However, the number of hospitals who have carried out such work is still low; i.e., a very few number when compared to the hundreds or thousands of healthcare centres in Europe. In the knowledge that healthcare districts consume huge amount of energy, the number of hospitals that carry out retrofitting and refurbishment to reduce their energy consumption shall increment drastically during the next few years, if we are interested in reducing the CO2 emissions of healthcare districts and their impact on the environment. It is also important to mentions that improvements, alterations and additions to healthcare buildings depend on many factors that should be examined closely since what works for one site or organisation may not necessarily work for another. This is why to achieve the desired energy efficient outcome there are many options available, but each site is individual so every case must be investigated separately and judged on its own merits. As for STREAMER, the provided decision-making tools and guidelines shall help refurbishing existing hospitals or designing energy efficient healthcare buildings. Furthermore, On the one hand, STREAMER shall improve the State of the Art on tool level as it should provide the BIM and ICT software suitable to identify, control and assess all the energy related features during the design or operation phase of a hospital.

Regarding the regulations, codes, and legislations, it is clear that all the studied countries have realized the importance of implementing energy efficiency in new and existing buildings. These countries have worked to set the rules and define the objectives regarding energy-efficient building. Progressive codes and standards are being adopted world-wide and the European Commission is implementing the Energy Related Products Directive (EC ERPD) which is setting minimum efficiencies on products sold in Europe including ventilation and energy recovery systems. These regulations are considered as a way to insure and increase energy efficiency in buildings. However, it is important not just to approve or propose the energy efficient building codes, but also to state the over-time costs of implementing such codes, and how the invested capitals are amortised over time. Furthermore, the laws, guidelines and codes are not really sufficient to ensure energy efficiency in buildings, since they have to be accompanied by supporting zero-energy buildings and setting up initiative packages, for new and existing buildings, to address the barriers in implementing energy efficiency in them. Finally, it is important to review the existing codes and laws every now and then to try include the latest technologies for reducing energy consumption. Finally, please note that not always the EeB rules established are respected or the energy aspects well assessed, either in design and operation phase. This happens often due to lack of resources and tools. STREAMER shall fill the gap between the existing and future legislations and regulations by providing design assessment tools that could help the involved actors to easily evaluate the energy related features while designing and monitoring them. Furthermore, the methodologies and tools regarding semantic-driven design methodologies including semantic BIM and GIS tools, which will be developed within the STREAMER-project, may help to avoid the risk of lack of communication between project partners and between different development phases of a project.

Regarding the research projects and conferences, although there are many research projects, conferences, and other initiatives on reducing energy consumption in buildings and healthcare centres, and its impact, it is clear that further research and development shall be undertaken in buildings and intelligent design of highly energy efficient buildings.

Regarding the current practices and technologies, we can conclude that many healthcare districts have implemented the latest technologies and efficient design to ensure reducing energy consumption. On the longer term, these technologies shall help increase energy efficiency of the buildings and reduce their environmental impact. The examples of best practices in Swedish hospitals presented in this report show that there is a large potential for energy savings by using already existing technologies, by optimising the operation of ventilation systems already installed and by utilising local energy sources. However, the good energy efficiency already achieved among the Swedish hospitals is a result of the use of a BIM-oriented IT-system called Program for Technical Standard for hospitals (PTS), which is an example on how BIM and ICT software provided by STREAMER shall help reducing the energy consumption at healthcare centres by 50%: the Swedish hospitals already have less than half of the energy demand compared to many other hospitals in Europe.

Further than the previous conclusions, some guidelines have been identified in our study to implement energy efficiency in healthcare centres: first, goals to be achieved shall be clearly defined, and agreed by all participants such as politicians, decision-makers, architects. These goals shall be measurable and KPIs for their evaluation shall be defined. Then, an inventory of current situation shall be surveyed to identify the weight of the previously identified KPIs. Finally, it is important to choose the correct form of procurement for energy efficient medical equipment and for energy renovation projects.

The next step, and after analysing the current state of the art in European practices at healthcare centres, and after analysing STREAMER's demonstration sites, it is time to show that there is a large energy saving potential in the demonstration projects, and that STREAMER results shall help identify the improvements and practices that shall be carried out to achieve the 50% energy reduction in healthcare centres during the next years.

13. References

Advantage Environment, 2009. Stored snow for summer cooling. Article published at Advantage Environment, available from: http://advantage-environment.com/byggnader/stored-snow-for-summer-cooling/ (141217).

Boverket, 2014. Swedish Building Regulations (Boverkets Byggregler Avsnitt 9 BFS 2011:6 ändrad t.o.m. BFS 2014:3, in Swedish), Boverket – the Swedish National Board of Housing, Building and Planning (www.boverket.se, 150119).

Lagerkvist, Knut-Olof and Walter, Anders, 2012. Consequences of the long-term goal to cut energy use by half by 2030 (Konsekvensutredning av det långsiktiga energimålet att halvera energianvändningen till 2030, in Swedish. Västfastigheter Report 111214. Available from: http://vastfast.vgregion.se (141217).

Landstinget Västernorrland, 2010. Environmental and energy plan for the Västernorrland County 2010-2014 (Miljö- och energiplan för Landstinget Västernorrland 2010-2014, in Swedish). Available from: http://www.lvn.se/PageFiles/3059/Milj%C3%B6-%20och%20energiplan%202010-2014_web2.pdf (150119)

Locum, 2014. Statistics for energy and water 2013 (Årsbok för energi och vatten 2013, in Swedish). Available from: http://www.locum.se/upload/Miljo/E-%C3%A5rsbok%202013.pdf (141217).

Löfvendahl, Anders, 2013. Article about Sundsvall Hospital. Published in Ljuskultur 3/08. Available from: http://ljuskultur.se/files/2013/05/Sundsvalls_sjukhus.pdf (141217).

Nutsos, Mikael, 2009. Article about energy saving measures implemented at Karolinska university hospital in Huddinge.

SALAR, 2015. Swedish Association of Local Authorities and Regions (www.skl.se, 150122).

SCA, 2014. Energy requirements in the Swedish public sector (in Swedish). The Swedish Competition Authority http://www.konkurrensverket.se/upphandling/aktuella-teman/energi-och-klimat/energikrav-i-offentlig-sektor/ (150119).

SDHA, 2009. Fjärrvärme - A Real Success Story (in Swedish). Swedish District Heating Association (www.svenskfjarrvarme.se, 101013).

SEA, 2008. Energy use in health care premises. (Energianvändning i vårdlokaler. Förbättrad statistik för lokaler, STIL 2, in Swedish). Swedish Energy Agency, report ER 2008:09. Available from: www.enerimyndigheten.se (150120)

SEA, 2011a. Overarching grasp of energy savings halves the energy needs in premises, press release. Available from: http://www.energimyndigheten.se/en/About-us/Press-/Press-releases/Overarching-grasp-of-energy-savings-halves-the-energy-needs-in-premises/ (150120).

SEA, 2011b. Summary of energy statistics for dwellings and non-residential premises for 2010 (in swedish). Swedish Energy Agency (www.energimyndigheten.se, 120422), Report ES 2011:11.

Sjödin, J., 2003. Swedish District Heating Systems and a Harmonised European Energy Market. Dissertation No. 795. Linköping University of Technology.

SKL, 2014. Energy and climate 2014 – buildings and transports in municipalities and counties (Energi och klimat 2014 – Byggnader och transporter i kommuner och landsting, in Swedish). Available from: www.skl.se (150122).

Snowpower, 2014. Schematical figures. Available from: http://www.snowpower.se/resultat_sundsvalls-kylanlaggning.asp (141217).

Sterner, T., Höglund Isaksson, L., 2006. Refunded emission payments theory, distribution of costs, and Swedish experience of NOx abatement. Ecological Economics 57, 93-106.

Sterner, T., Köhlin, G., 2003. Environmental Taxes in Europe. Public Finance and Management, Vol. 1, 2003. Available from SSRN: http://ssrn.com/abstract=461537 (2012-05-07).

TMR, 2010. Energy future of the Stockholm region 2010-2050. Energy study for the Stockholm region - Final report, Growth, Environment and Regional Planning (TMR). Available from: http://www.tmr.sll.se/Global/Dokument/publ/2010/2010_r_energy_future_of_the_stockholm_region_2010-2050.pdf (150120).

UFOS, 2015. Offentliga fastigheter (UFOS, www.offentligafastigheter.se, 150122).

Central Statistic Office of Poland website. (s.d.).
http://stat.gov.pl/

National Found of Environmental Protection and Water Management website. (s.d.).
http://www.nfosigw.gov.pl/

Polish Energy Policy until 2030. (s.d.).
Polskie sieci elektroenergetyczne website. (s.d.).
http://www.pse-operator.pl/index.php?dzid=171&did=1053#r5_1

APPENDIX 1 - Further pictures on energy saving methods

Overview AMC

Figure 19 Overview AMC area (power station in the middle – below)

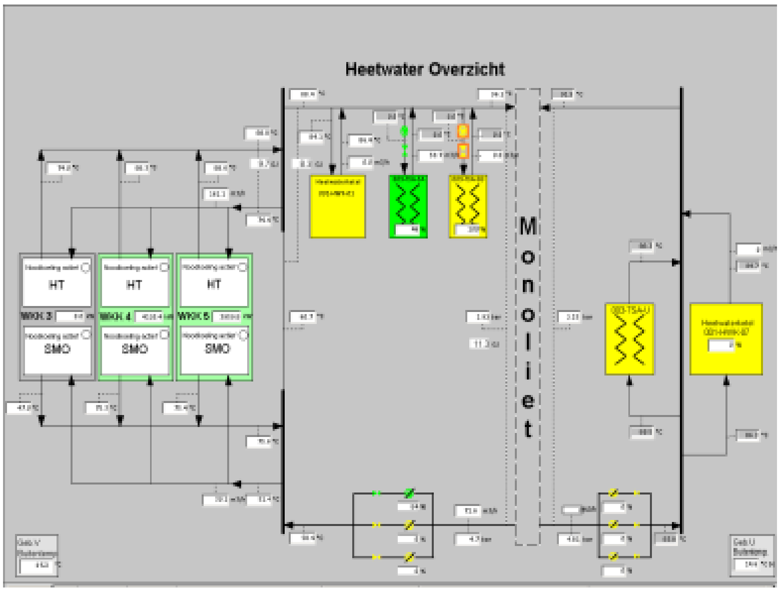


Figure 20 Simplified Hot water diagram (heating)

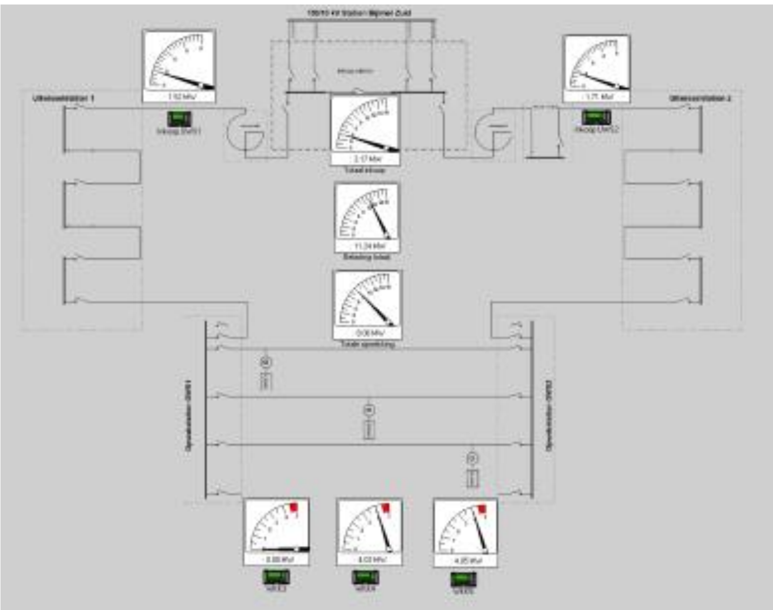


Figure 21 MV diagram including CHP units (simplified)

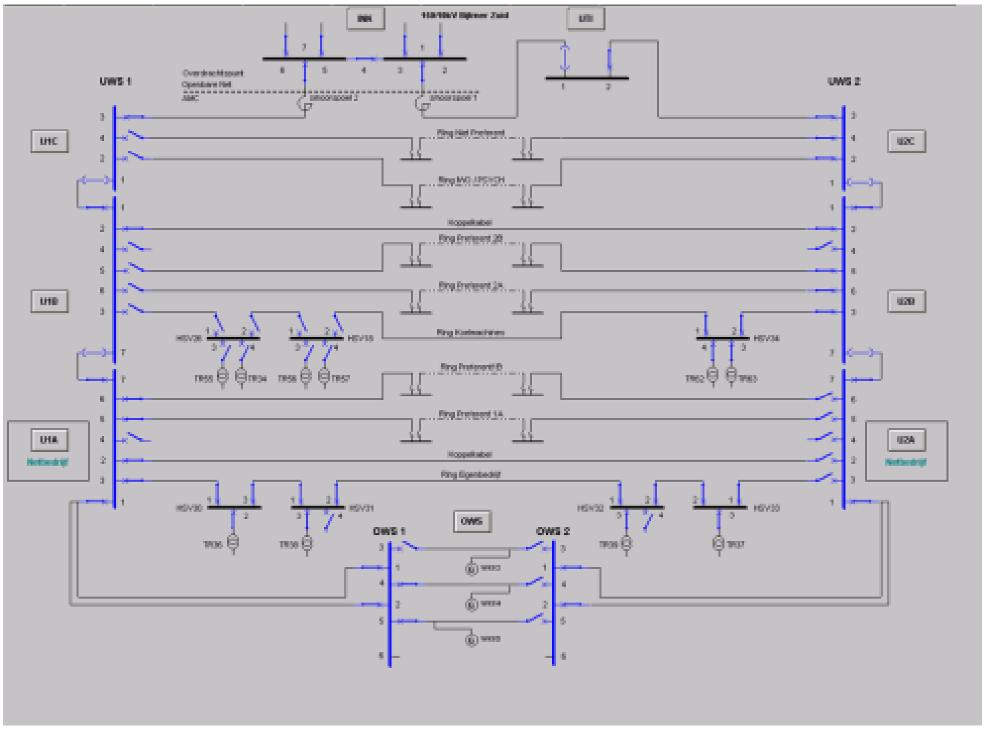


Figure 22 MV distribution diagram

Rijnstate Hospital

Figure 23 Cooling tower