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Towards an eco-efficient economy

– 12 Swedish examples

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FOREWORD

We are currently experiencing several global crises. The global climate challenge is coinciding with the economic crisis. A crisis can be used as a turning point – as a unique opportunity for a change that is needed. During Sweden's Presidency of the EU we aim to emphasise the opportunities presented by an eco-efficient economy as a response to the climate challenge and the economic crisis.

The theme of an eco-efficient economy will be common to several different councils of ministers. The meetings are intended to bring about a common understanding of the opportunities open to Europe to overcome the economic crisis by following a green path towards competitiveness, prosperity and new jobs.

By highlighting examples, we aim to show how committed and proactive environmental efforts can lead to international competitive advantages. At the same time, the Swedish Presidency intends to contribute to discussions on how a new Lisbon Strategy for jobs and growth will lead to a greener Europe. This also represents an opportunity to strengthen the EU's position ahead of the climate negotiations in Copenhagen.

The Earth's population is expected to grow from six to nine billion by the mid-21st century while the world economy continues to grow four or five times. It will present great challenges, both for the green economy and for the environment.

> Investing in something that is new, efficient and environmentally friendly must prove to be rewarding.

There will be great need for new products, services and system solutions that help contribute to the switch. An eco-efficient economy can point the way to new jobs and replace some of the jobs now being lost in European industry. Small and medium-sized enterprises have a key role to play in achieving new, innovative solutions, growth and jobs.

The challenges Europe faces need to be met in a concerted way in various areas of policy such as environment, energy, industry, research and trade. We need efficient technology and smart system solutions, but also adapted institutions and instruments. Environmental taxes and other economic instruments such as carbon dioxide tax have proved to be effective tools in severing the link between increased growth and greenhouse gas emissions. Doing the right thing proves worth the expense. Investing in something that is new, efficient and environmentally friendly must prove to be rewarding.

Sweden is one of the European countries with experience of long-term climate efforts, where switching of the energy system and reduced green-

> A switch to an eco-efficient economy before the rest of the world can provide us in Europe with significant competitive advantages.

house gas emissions have been combined with economic growth. Emissions have fallen by just over 9 percent since 1990, while the rate of economic growth has been around 48 percent. We have favourable experience of economic instruments to encourage a switch and efficiency improvements in industry. This publication presents 12 Swedish examples that provide inspiration and knowledge towards an eco-efficient economy in Europe.

Europe's response to the economic crisis should be to allow environmental solutions to get the economy and investments moving. A switch to an eco-efficient economy before the rest of the world can provide us in Europe with significant competitive advantages. Improved competitiveness and growth can be achieved at the same time as a sustainable energy supply, efficient use of resources and fulfilment of our climate and environmental objectives.


Pawel Flato

Maud Olofsson
Minister for Enterprise and Energy


Pawel Flato

Andreas Carlgren
Minister for the Environment

12 SWEDISH EXAMPLES

Ulf Bergström/Stockholms stad

Renova

AN ECO-EFFICIENT ECONOMY

- is a key factor in overcoming the climate crisis and in sustainable development in a broader perspective.
- is aimed at boosting EU competitiveness, as the entire growing, industrialised world is facing the same environmental and growth challenge as Europe.
- increases business opportunities in the areas of renewable energy, environmental technology, energy efficiency, sustainable transport and vehicles, tourism and agriculture.
- promotes innovations and the development of environmental technology and more environmentally friendly products and services.
- reduces dependence on imports of energy and raw materials and consequently also sensitivity to wide price variations.
- requires integration and collaboration between many policy areas as well as between private and public-sector actors.
- has what is needed to create a common positive challenge for Europe from the crises.

BUILDING A SUSTAINABLE URBAN DISTRICT FROM THE GROUND UP

A new district has emerged around the lake of Hammarby Sjö in Stockholm. A run-down port and industrial area has been cleaned up, developed and converted into a modern and environmentally sound district. Hammarby Sjöstad is Stockholm's largest urban development project. A special organisation in the Stockholm City Development Administration is responsible for the construction project. The lakeside town has its own environmental programme which incorporates consideration of the energy supply, water and wastewater treatment and waste management.

Lennart Johansson/Stockholms stad

Hammarby Sjöstad is a natural extension of Stockholm city centre, which is a feature of the design of infrastructure, urban planning and the built environment. This extension has necessitated extensive reconsruction of the infrastrucure in which transport barriers have been removed and old industrial and terminal sites have been closed down, concentrated or given new uses.

Large-scale project with many investors

When development of the Hammarby Sjöstad has been completed, the district will contain 11,000 apartments. It is estimated that 35,000 people with live and work in the area. All areas of the district have mixed forms of tenure. The ratio between tenancy and tenant ownership is 45:55. In conjunction with the expansion of Hammarby Sjöstad development of the area's municipal and commercial services is also taking place, as well as increased investment in public transport.

Many different parties have been involved in making it possible for the district to be financed. When the entire construction project is finished the cost will total SEK 45 billion. The City of Stockholm has taken the initiative for the establishment of Hammarby Sjöstad together with around 25 different construction companies. The construction companies' investment represents just over 80 percent of the costs of the whole project. The net investment for the City of Stockholm is SEK 2 billion. Other funding comes from the government agencies the Swedish Rail Administration (rail transport) and the Swedish Road Administration (routing of the Southern Link road).

The City of Stockholm's environmental objectives for Hammarby Sjöstad

The City of Stockholm set stringent environmental requirements for buildings, technical installations and the traffic environment right from the start. The aim of the environmental programme is halve the total environmental impact in comparison with an area built in the early 1990s.

When Hammarby Sjöstad was built, nature was preserved as far as possible, and new green spaces were created. The land was decontaminated and old industrial land was transformed into attractive residential areas with fine parks and open spaces. As transport has a heavy environmental impact, a major public transport initiative was taken in the area with the cross-rail service Tvärbanan, bus services and a ferry service on the lake Hammarby Sjö between the southern and northern ends of the new district. The ferry is operated by the City of Stockholm and is free. Car pools have also been opened both for residents and for people who work in the area.

Environmental concerns also apply to all materi-

> When construction of Hammarby Sjöstad has been completed, residents in the area will produce half the energy they need.

als used, both for the visible materials on buildings and on the ground and for material inside the buildings – carcass, installations and equipment. The underpinning idea is to use proven, sustainable materials and products with environmental declarations, and not to use chemical products or building materials containing hazardous substance. Another aim is for the district to be healthy for residents and for there to be opportunities for exercise, sport and culture locally.

Sustainable and renewable energy

When construction of Hammarby Sjöstad has been completed, residents in the area will produce half the energy they need. Environmentally friendly energy is used in the form of renewable fuels and re-use of waste heat, as well as biogas products combined with efficient energy use in properties. In the Hammarbyverket plant, heat is extracted from the treated wastewater and cooling for the district cooling network is obtained as a by-product.

The Högdalen co-generation

At the Högdalen co-generation plant, separated combustible waste is used as an energy source in the production of electricity and district heating. Another example of sustainable heat supply is that at the Hammarby thermal plant waste heat is extracted from the treated wastewater piped from the

Ulf Bergström/Stockholms stad

Henriksdal sewage treatment plant. There is also centralised production of district heating and district cooling. Cooling is exchanged with the water circulating in the district cooling network in Hammarby Sjöstad from the cooled treated wastewater leaving the heat pumps of Hammarbyverket. The cooling is thus a clean by-product of district heating production.

There are also several photovoltaic cell installations in Hammarby Sjöstad. The light energy of the sun is captured and converted into electric current in photovoltaic cells. Photovoltaic cells are installed on several walls and roofs in the area. There are also solar panels in one block of buildings. These capture the warmth of the sun, which is then used to heat water.

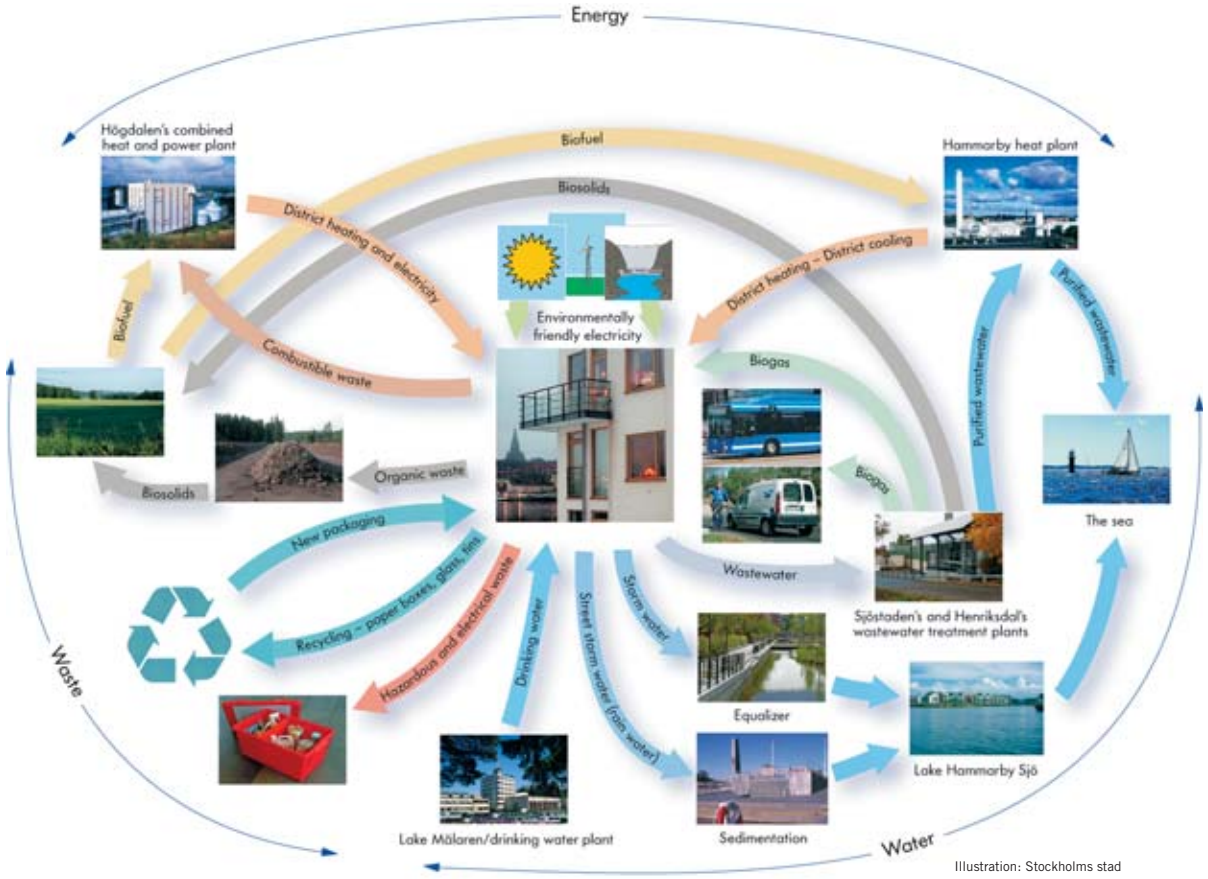

Illustration: Stockholms stad

The Hammarby model

The Hammarby model is a unique cycle system that integrates energy, solid waste, water and wastewater for homes, offices and other activities in the area. The cycle is also intended to serve as a model for the development of equivalent technical systems in cities (see illustration).

All stormwater, rainwater and meltwater is managed locally in various ways.

Domestic refuse is separated into different chutes, including for the stationary system. The various fractions are then transported by vacuum to containers in a central collecting station.

FOCUS ON GOOD-QUALITY HOUSING AT REASONABLE COST

The brief for the Flagghusen block in Malmö was to build homes at reasonable cost and with a high level of sustainability. It was a case of making sustainability the norm – and going beyond what is required by laws and regulations. The City of Malmö initiated a dialogue with 13 developers, and a sustainability agreement that everyone undertook to abide by was reached.

Flagghusen represent the new generation of sustainable construction in Malmö's Västra Hamnen district. Västra Hamnen is a leading international example of sustainable urban development. In the first stage the noted demonstration project Bo01 was built on old industrial land in the shipyard area. Bo01, Sweden's first climate-neutral urban district, was built as a European housing exhibition in 2001 – City of Tomorrow. It was created as a demonstration project and was to show the world that sustainability can be attractive.

When a decision was taken in 2004 that the land north-east of Bo01, which came to be known as Flagghusen, was to be developed, the objective was to build homes at reasonable cost and with a high degree of sustainability. It was a case of showing that sustainable construction need not be expensive. Experience gained from Bo01 was put to use, but aspirations were set even higher. In the Flagghusen block high sustainability has been successfully combined with apartments available at reasonable rent. The block consists of 16 properties and just over 600 apartments, two-thirds of which are rented. The project is now being completed while

Miljöförvaltningen/Malmö Stad

a dialogue is taking place at the same time on the next stage of the area, the Fullriggaren block, where the level of ambition is being raised even higher.

The "useful conversation" on Flagghusen

The key to the success of Flagghusen is dialogue. April 2004 saw the start of the "useful conversation". The City of Malmö initiated a dialogue on architecture, planning issues, environment and quality together with 13 development and involved members of the public. The aim was for the conversation itself – the dialogue – to lead to a complete detailed development plan for good-quality and sustainable housing at reasonable prices. The idea was that the

developers would benefit from one another's knowledge. By working together, they would be able to develop new sustainable solutions and lower their production costs. The "useful conversation" was focused on four aspects of sustainability:

- High architectural quality.
- Social sustainability: flexible design of housing, safety and security, meeting places.
- Economic sustainability: housing at reasonable cost through an efficient and careful process.
- Ecological sustainability: energy efficiency, phasing out of toxic substances, high biological quality and kerbside separation of waste.

The sustainability agreement

The agreement enumerated a number of items that everyone wanting to build in the area undertook to abide by:

- The rental apartments are to be let at reasonable cost. (Around SEK 1 300 per square metre per year)
- Varied architecture – distinguishable facade lengths of no more than 25 metres provide human scale.
- Low energy use reduces costs (total energy use must not exceed 120 kilowatt hours per square metre per year).
- Healthier indoor environment when the buildings are constructed with moisture control and toxic substances have been minimised (the 'BASTA' system).
- Basic design of the residential buildings makes them usable in the various stages of life – it will also be possible for someone to live here when become less mobile.

Miljöförvaltningen/Malmö stad

- Security – the area is designed and planned to create a secure local environment.
- A particular proportion of the site has to be green (the 'green area factor' is applied).
- A number of green one-off initiatives are taken to improve biodiversity.
- Kerbside separation of waste – containers in every courtyard.

The Building-Living Dialogue

The 'useful conversation' is one of the commitments in the Building-Living (Bygga-bo) Dialogue – a form of cooperation between companies, municipalities, authorities and government. The aim is to go further than laws and regulations require with the Building-Living Dialogue. The common target is to achieve a sustainable construction and property sector by 2025, principally in three prioritised areas: indoor environment, energy use and use of natural resources.

ADAPTING THE OLDER BUILT ENVIRONMENT TO MODERN REQUIREMENTS

The district of Gårdsten in north-east Gothenburg is a 'million new homes programme' area that has been given a new face. The district has changed character in major respects in a decade. The buildings have been renovated and the outdoor environment has been freshened up. The residents report in annual surveys that they enjoy living there, and there is strong demand for apartments. Ideas relating to a sustainable society have permeated the whole transformation.

The Gårdsten district was in great need of upgrading when Gårdstensbostäder was formed in 1997 and bought the just over 2 000 apartments in the district Collaboration between professionals and non-specialists was needed to bring about the renovation of the 'million new homes programme' buildings. The housing company involved the tenants, who presented their ideas to architects and building engineers.

Environmentally sustainable areas

Gårdstensbostäder has undertaken consistent and systematic environmental work from alternative energy solutions to recycling. As a result, the company is now self-sufficient in environmentally friendly wind-generated electricity, produced right next to the properties.

Solhusen

The extensive renovation project of Solhusen ('Solar Buildings') attained the goal of reducing future maintenance and energy use, lowering housing costs and applying modern recycling technology.

Gårdstensbostäder

The tenants were also to be given an opportunity to influence their costs for example through the metering of electricity, heating and water.

The Solhusen buildings have attracted wide attention both in Sweden and abroad. In 2001 the project won the Swedish Association of Painting Contractors prize for the best painting environment. In 2002 Solhusen was awarded the Great Energy Prize for individual metering, and in 2005 it won the "World Habitat Award" of the Building and Social Housing Foundation.


Gårdstensbostäder

The first area of solar buildings, Solhus 1, comprised three courtyards with 255 properties, and was built under an all-in contract with Skanska as main contractor. Preparatory work began in the spring of 1998, and the first tenants took up residence in March 2000. The second part of the project, Solhus 2, was completed in the autumn of 2003. Solhus 2 contained roughly the same number of properties.

The buildings are constructed of concrete panels and have flat roofs. There are two types of buildings, balcony-access blocks with three or five floors, and slab blocks with entrances at floor level and internal staircases to three floors. The balcony-access blocks have balconies facing south along the whole length of the building, while the slab blocks have inset balconies facing east and west. District heating was installed as part of the renovation, and the blocks were given exhaust-air and supply-air systems for ventilation. Solar panels were installed on the balcony-access blocks to supply hot water to the buildings via accumulator tanks in the basement. The balconies were glazed in to protect the outside walls, reduce heat loss and increase their use. The ground floor in Solhus 1 has also been glazed in and provided with greenhouses which are used to grow plants for the tenants. There are also new laundries here. In addition, composting machines were installed to convert household waste to soil, which is used in the greenhouses.

New energy solutions

The project comprised a well thought-through renovation in which most of the costs of energy measures were covered by reduced operating expenses. The energy-related measures can be summarised in the following items:

- Conversion to exhaust-air ventilation (F system) in the balcony-access blocks and installation of heat recovery (FTX system) in the slab blocks.
- Glazing-in of balconies.
- Replacement of the inner pane with low-emission glass in existing double-glazed windows.
- Roof-integrated solar panels.
- Additional insulation of roods.
- Additional insulation of end walls.
- Insulation of plinths.




Gårdstensbostäder

- New washing machines and drying room equipment connected to hot water.
- New energy-labelled white goods.
- Installation of a central control and monitoring system.
- Installation of individual metering for electricity, heating and hot and cold water.

Cost and financing of the project

The renovation project has been carried out in cooperation with five European housing projects, which with assistance from the European Commission have been able to implement the energy and ecocycle-related measures. The Swedish government agencies Nutek and Formas have contributed with national funding.

The production cost for the renovation and construction of Solhusen was SEK 105 million, which is equivalent to around SEK 5 600 per square metre.

The production cost for energy-related measures was SEK 20 million, equivalent to around SEK 1 100 per square metre. The renovation led to a decrease in energy costs of SEK 1.6 million in 2004, equivalent to just over SEK 6 000 per apartment.

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“EUROPE’S GREENEST TOWN”

The Municipality of Växjö took unanimous political decisions on environmental issues as long ago as 1969. In the 1980s bioenergy was introduced into heating, and renewable energy now accounts for more than 90 percent of all heating in Växjö. In 1996 the decision was taken that Växjö should become free of fossil fuels, and this has been followed by many large and small projects in broad consensus on energy and transport. The result is that Växjö has reduced its carbon dioxide emissions by 32 percent per head of population. The target is to halve emissions by 2010 and achieve a 70 percent reduction by 2025.

Mats Samuelsson

The Municipality of Växjö has received several international environmental awards in the current decade and has been dubbed "Europe's greenest town" by the BBC and other international media for its climate targets and successful efforts on climate change. Europe's greenest town is the sum of all the environmental projects that have been implemented and will be implemented in the Municipality of Växjö, both private and public.

Free of fossil fuels

The background to the Municipality of Växjö's climate strategy is that many people know what climate change means, while also having the ability to see opportunities instead of obstacles. This has led to a consensus among politicians and the business community, the public and local associations: we must stop using fossil fuels.

An overarching objective is for the Municipality of Växjö to endeavour to use energy from renewable energy sources, use energy efficiently and switch to a transport system free of fossil fuels. One of the interim targets is to reduce fossil carbon dioxide emissions per head of population by at least 50 percent by 2010 and by at least 70 percent by 2035, in comparison with 1993.

Environmental projects

The Municipality of Växjö has received partial funding for environmental and climate projects through the local investment programmes (LIP) and the climate investment programmes (KLIMP), as well as EU grants. Decisions on Timber in Construction were taken in 2005, leading to a substantial commitment to the construction of timber buildings. Today two timber high-rise buildings are being built by the passive technique. In 2005 the Municipality of Växjö for the first time specified requirements for energy-efficient construction in the sale of municipal land. In 2008 one of the largest photovoltaic cell systems in Sweden was installed at the Kungsmad upper secondary school in Växjö. Further details on what has been implemented, is under way and is planned in Växjö follow below.

> "The strategy is to make it easy to live a life without fossil fuels.

Influencing behaviour

It is very difficult to get people to change their behaviour if it means making financial sacrifices or changing their lifestyle. A change-over to biofuels and energy efficiency improvements is often economically advantageous and also convenient where district heating is concerned, while far more is needed to persuade someone to cycle rather than drive. The strategy is to make it easy to live a life without fossil fuels, for example cheap and convenient district heating, attractive public transport and good foot-

Växjö kommun

paths and cycle paths, and in the longer term also biofuels.

Energy efficiency improvements

The best energy is that which never needs to be used. Several studies and measures show that it is possible to achieve a reduction in energy use of 20 percent. Under the EU project SESAC, municipal housing companies and private developers build in an energy-efficient manner. Växjö coordinates SESAC, which comes under the Sixth Framework Programme for research and development and is part of the European Commission's Concerto initiative. The objective is to build sustainable energy systems by increasing the use of renewable energy sources for energy production and reducing total energy use by becoming more energy-efficient. This also includes improving energy management systems and ensuring that the "entire chain" in the municipality does the right things at the right time.

Biofuel

Oil and electricity for heating will be replaced by biofuel-based district or local heating wherever possible. Environmentally approved small-scale biofuel burning (pellets or wood) is otherwise the best alternative.

Transport

With regard to transport it is important firstly to reduce the rise in traffic levels and secondly to replace fossil fuels with renewable fuels. Initiatives to provide good opportunities for walking, cycling and travelling by public transport are an important part of this work. Biogas has been available as a fuel for a small number of cars since 2007. With effect from 2011 household food waste will be separated and turned into biogas for urban buses and other vehicles. Work on the fuel DME (dimethyl ether) has been most a major feature, and there are hopes for the gasification of biomass for further processing into vehicle fuel and a large-scale production plant. Växjö Energi is a partner in the research facility for the gasification of biofuel in Värnamo and is taking part in the EU project Chrisgas.

ELECTRICITY AND DISTRICT HEATING – WITH RESERVE TANK

In the Jämtkraft co-generation plant it is possible to produce electricity and district heating at the same time. The plant's efficiency is around 90 percent and energy is produced with renewable biofuel. The co-generation plant provides electricity and heating to tens of thousands of households, and operation is controlled by the need for heating in the district heating system and the demand for renewable electricity.

The Jämtkraft co-generation plant has been operational since 2002, and produces electricity and district heating at the same time, at a high efficiency of around 90 percent. A third of the production is electricity and two-thirds is district heating. Renewable biofuel is used to 99 percent in production, and is handled efficiently and with minimal losses. Most of the biofuel consists of forms of energy that would otherwise go to waste, for example parts left over from forest felling, by-products from sawmills and waste wood. Peat is also used.

Jämtkraft

Efficient production of electricity and heating.
Water is heated to steam in the boiler. The steam is then passed to a turbine, where it expands and causes the turbine to rotate. The turbine in turns drives a generator, which produces electricity.

The steam is passed from the turbine to a condenser. There it is cooled to water, and the energy content is transferred to the district heating network in a heat exchanger. The hot water is pumped out into the district heating network and heats Östersund and surrounding area. The condensed steam, the feedwater, is pumped back to the boiler to be heated up again and be turned into steam, district heating and electricity.

The flue gases from combustion also provide district heating. They are cooled by the water returned from the district heating system and heat is extracted when the water vapour in the flue gases condenses. All that escapes from the stack is hot air, water vapour and CO_2 from renewable biofuel.

The output of the co-generation plant is 45 MW of electricity, 80 MW of heating and 30 MW of flue-gas condensation.

Daniel Gustafsson

In 2008 the co-generation plant produced 240 GWh of electrical energy and 492 GWh of thermal energy.

Arctura – accumulator tank

Arctura, which was added in 2004, is the district heating system's accumulator tank. Arctura is a rechargeable water battery containing 26 million litres of water and up to 1 500 MWh of energy. It is an energy reserve which enables Jämtkraft to maximise the benefit of the valuable electricity production, safeguard district heating supplies and minimise the need for oil.

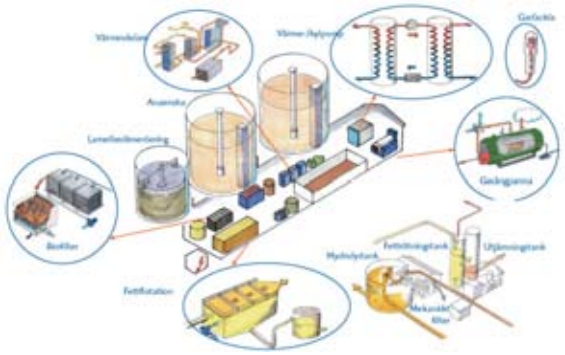
The energy content of Arctura in winter-time is equivalent to a 20 MW oil-fired boiler. Arctura extends the operating time of the co-generation plant by two months a year.

District heating – a resource-efficient form of heating

District heating is an efficient way of heating buildings in built-up areas. Instead of everyone having their own heating systems, district heating is delivered from a central plant with efficient combustion and excellent treatment of flue gases. As a result, various renewable forms of energy that would otherwise be lost can be used. Water as an energy carrier can easily be heat-exchanged from thermal plants to district heating networks and finally to individual buildings, with minimal energy losses.

BIOGAS FROM WHEY

The Norrmejerier plant in Umeå is the first dairy in Sweden to have its own biogas facility for the recovery of residuals. Turning effluent and waste products into an energy resource by the biogas technique reduces the consumption of fossil fuels. This initiative additionally increases capacity for cheese-making, which means that the investment is not just advantageous for the environment but also makes the dairy more competitive.



Norrmejerier's biogas facility in Umeå was officially opened in 2005. This plant is the first of its kind in Sweden and one of the few in Europe to make use of whey in both an environmentally efficient and energy-efficient way. High-value proteins in the whey can be extracted, while the residual produces biogas, which means that the dairy saves on fossil oil. At the same time it is an opportunity for Norrmejerier to find a regular market for its whey and undertake profitable milk production.

The dairy today meets a large proportion of its own energy needs and has reduced its oil consumption by the equivalent of 2 500 m^3/year. This solution leads to reduced emissions of greenhouse gases, sulphur dioxide and nitrogen oxides from fossil fuel (NO_x is reduced by 9.3 tonnes/year, SO_x by 3.9 tonnes/year and CO_2 by 9 500 tonnes/year). At the same time transportation is reduced by the equivalent of 20 000 km/year.

The payback period for the project is estimated at 6–8 years.

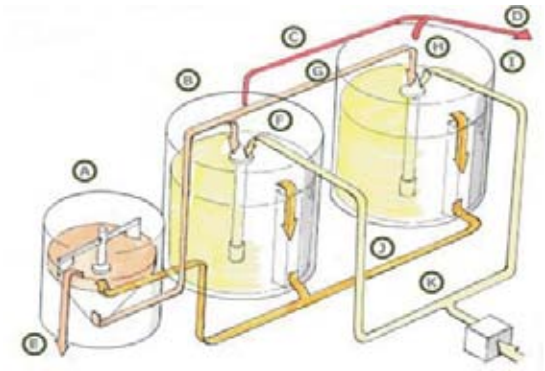
Use and distribution of biogas

The biogas formed replaces oil and is utilised for the production of process steam at the dairy in a biogas-fired steam boiler. Around 10 000 MWh of biogas is produced annually. A further 7 000 MWh of energy is obtained via a heat pump.

Description of process

The principle of the biopurification process is based on process wastewater and other energy-rich waste products undergoing a microbiological, bacterial breakdown process under oxygen-free (anaerobic) conditions. The organic matter is broken down to

biogas which is then burned in a gas steam boiler for the production of high-pressure steam. The steam is consumed in the dairy's processes. Norrmejerier's whey production undergoes further processing by ultrafiltration. A large proportion of the proteins in the whey is filtered away by this technique. The proteins have high added value and can be utilised as raw materials in new foods. The remaining whey (lactose) goes for digestion and together with the dairy's effluent and other waste products is converted to biogas. The heat in outgoing wastewater is heat-exchanged with the incoming flow to be finally utilised in a heat pump. The energy can then be utilised for the heating of premises and hot tap water to meet the dairy's internal needs.



Norrmejerier's biogas process is based on two anaerobic reactors of 2 500 m^3 each. The substrate is pumped into the top of the reactors (F, H). The outflow (J) is pumped to a lamella sedimentation unit (A). The sludge is recirculated (G) for maintain bacterial tightness. Biogas is transported to a gas steam boiler via (C). The treated water flows out via (E).

> The solution leads to reduced emissions of greenhouse gases, sulphur dioxide and nitrogen oxides from fossil fuel.

SURPLUS HEAT IN SWEDEN

Preem is the largest Swedish oil company and has two systems for the recovery of surplus heat. Using surplus heat from industry is one way of meeting heating needs in society without producing greenhouse gases in the form of carbon dioxide. In 2008 Preem's refineries delivered surplus heat which would be sufficient to heat around 36 200 medium-sized detached houses. The saving is equivalent to a decrease in carbon dioxide emissions of around 152 400 tonnes.

General

Industrial surplus heat arises as part of and as a result of industrial production processes, for example in refining. Part of the primary energy needed to run a production process is not consumed and has to be cooled away for the process to work. The surplus heat is traditionally cooled to the surrounding air and/or water and then goes to waste. It can instead be put to use and produce a form of energy that does not cause any emissions.

Sweden was the first country in the world to exploit surplus heat and use it to save on resources and create a better environment in the form of reduced emissions of sulphur, nitrogen and carbon dioxide. Today Sweden is a world leader in this area.

Preem's surplus heat

Preem has two refineries on the west coast. Both refineries are considered to be among the most environmentally and energy efficient in Europe. This is due in part to their ability to supply surplus heat.

	GOR	LYR	PREEM
Carbon Emission Index	-28%	-11%	-15%
Sulphur oxides, SO_x	-94%	-84%	-86%
Nitrogen oxides, NO_x	-65%	-64%	-65%

> Sweden was the first country in the world to exploit surplus heat and use it to save on resources and create a better environment in the form of reduced emissions of sulphur, nitrogen and carbon dioxide.

Preem

Technical information – quantities of heat supplied in 2008

Preem refinery Gothenburg

To Volvo: Surplus heat is delivered via hot water at an outward temperature of 130 degrees and a return temperature of 90 degrees. Delivered surplus heat in 2008 totalled 143 GWh. This is equivalent to the consumption of around 14 900 m^3 of heating oil if the same quantity of heat was produced in Volvo's boiler houses, which would then generate carbon dioxide emissions totalling around 40 000 tonnes. This amount of heat would be enough to heat around 9 500 medium-sized detached houses.

To Göteborg Energi: Surplus heat is delivered via hot water at an outward temperature of 90 degrees and a return temperature of 50 degrees. Delivered surplus heat in 2008 totalled 363 GWh. This is equivalent to the consumption of around 37 800 m^3 of heating oil if the same amount of heat was produced in a boiler house, which would then generate carbon dioxide emissions totalling 101 700 tonnes. This amount of heat would be enough to heat around 24 200 medium-sized detached houses.

Preem refinery Lysekil

To Lysekils Energi: Surplus heat is delivered via hot water at an outward temperature of 90 degrees and a return temperature of 50 degrees. Delivered surplus heat in 2008 totalled 38 GWh. This is equivalent to the consumption of around 4 000 m^3 of heating oil if the same amount of heat was produced in a boiler house, which would then generate carbon dioxide emissions totalling 10 700 tonnes. This amount of heat is enough to heat around 2 500 medium-sized detached houses.

At Preem Refinery Lysekil there is, in addition, unutilised potential surplus heat estimated at 800 GWh, which would reduce carbon dioxide emissions by an estimated 224 000 tonnes annually.

LOWER EMISSIONS WHEN REFUSE IS TURNED INTO HEAT

In Gothenburg 30 percent of district heating and 5 percent of electricity come from refuse incineration in Renova's waste co-generation plant. The waste comes from households and businesses in Western Sweden. In the economic downturn spare capacity has arisen, creating opportunities to deal with waste that would otherwise have gone to landfill. Efficient energy recovery replacing landfilling means a sharp reduction in greenhouse gas emissions.

Renova AB is the leading environmental company in Western Sweden in the waste and recycling industry. Today Renova has several plants which in 2008 treated nearly 700 000 tonnes of waste, of which 450 00 tonnes went for incineration with energy recovery. The company is currently expanding its waste co-generation plant with the addition of a fourth incineration line.

The amount of waste is directly dependent on trends in society, and has increased by an average of 2-3 percent every year since 1900. The amount of waste received is falling sharply during the prevailing economic downturn, but will rise again as soon as the economy picks up. Construction of the fourth boiler will safeguard waste management and environmentally friendly energy production in Western Sweden for a long time to come.

Large investment

The fourth incineration line means an investment of more than SEK 600 million. It is due for completion in 2010 and, as well as the actual incinerator, will include complete equipment for flue-gas treatment.

Erik Yngvesson

Renova is making further investments of around SEK 100 million annually to ensure that the plant contains the best equipment from the point of view of the environment. The focus right now is on removing sulphur from the flue gases even more effectively in the existing plant.

Renova

Energy equivalent to a supertanker every year

The waste burnt at Renova provides electricity equivalent to the annual consumption of 60 000 apartments, as well as heating and hot water for 120 000 apartments. The plant contributes energy equivalent to more than 120 000 tonnes of oil per year. Energy recovery additionally replaces landfilling which would otherwise have led to large greenhouse gas emissions.

Today Norway buys incineration capacity in the Renova plant to deal with waste that would otherwise have gone to landfill. Capacity for incineration with energy recovery has not yet been sufficiently expanded in this country.

How the process takes place

The energy released from the waste, when it is burnt in one of the furnaces, is converted to steam in steam boilers. The steam that is produced goes to the steam turbine, which drives a generator where electricity is produced. Thermal energy is harnessed in the condenser after the turbine and supplied to the district heating network. Using flue gas condensation and absorption heat pumps, the heat in the flue gases can also be extracted – this too is supplied to the district heating network.

Energy totalling 3,3 MWh is obtained from each tonne of refuse burned, in the form of electricity and district heating. That is the amount consumed in heating a fairly large detached house for two months. A total of 1,3 TWh can be delivered every year.

Treatment three times over

The flue gases are treated in three stages. First the dust-borne particles are separated in an electric filter. The acidic gases are then scrubbed and condensed in a wet treatment stage to remove further dust particles and acidic gases. The third stage is a fabric filter that removes almost all dioxin and additionally ensures that the sulphur levels are reduced from 200 mg/cubic metre to less than 50 mg/cubic metre. A fourth stage in the process – catalyst treatment – is now being built, alongside the new incineration line. The net result is that Renova's waste co-generation plant easily meets present and future EU requirements for treatment.

LIGHT, STRONG AND SUSTAINABLE THANKS TO HIGH-STRENGTH STEEL

SSAB is one of the steel companies in the world to have made most progress in limiting emissions of carbon dioxide from production. The manufacturing of high-strength steels results in lighter, stronger and more durable end-products. At the same time a smaller quantity of raw materials and less energy are consumed. If the Eiffel Tower, for example, had been built of high-strength steel today, a third as much steel would have been used in its construction.

SSAB contributes to environmental improvements…

High-strength steel is stronger than ordinary steel. Less steel is consequently used in manufacturing, which in turn means lower emissions. Iron is produced by reducing iron ore using coal and coke in blast furnaces, a process that gives rise to carbon dioxide. With present-day technology it is difficult to limit emissions from iron-ore based steel production any further. International comparisons show, however, that SSAB's furnaces are among the best in terms of low emissions of carbon dioxide per tonne of crude iron. There are several reasons for this: high-grade raw materials in the form of iron-ore pellets, high-grade coke and efficient processes. It is also important that blast furnaces can produce without interruptions.

SSAB's total production of steel is based 47 percent on iron ore and 53 percent on recycled scrap raw material. This can be compared with the international average of 35 percent of steel produced from recycled material.

SSAB

Environmental efforts at SSAB are aimed at continuously developing efficient processes to reduce impact on the environment. The target is to reduce carbon dioxide emissions from production by two per cent per tonne by 2012. A decrease of two per cent per tonne of produced steel for SSAB is equivalent to 130 000 tonnes lower carbon dioxide emissions per year. This is the same environmental gain as would be achieved if 150 000 cars per year were

> SSAB's commitment to high-strength steel is based on close cooperation with its customers.


SSAB

replaced by green cars or if domestic aviation reduced its emissions by 20 percent.

…and enhances customers' competitiveness

In 2008 SSAB decided to invest SEK 5.3 billion in further developing the production of high-strength steel. These investments were intended to be implemented in stages and to be fully completed in 2012. SSAB's commitment to high-strength steel is based on close cooperation with its customers, in order to constantly find new applications. The French company Kuhn has developed a new grass mower in advanced high-strength steel together with SSAB. By using the high-strength material, Kuhn has succeeded in creating a 20 percent lighter design which, in addition, is 30 percent stronger than a design in traditional steel.

The Swedish mining company LKAB has developed an ore truck in high-strength steel. This has meant that the truck has become far lighter and can now take a 25 percent greater load than previously, which reduces the use of energy per tonne of ore transported.

SSAB on its own has developed a completely new design for a free-hanging dumper body made of high-strength steel. The new dumper body weighs only half as much as a traditional dumper body. The design consequently has increased load capacity and a lower unladen weight, lower fuel consumption and fewer and shorter maintenance stoppages. SSAB has around 9 200 employees in 45 countries and production facilities in Sweden and the United States.

VOLVO TRUCKS – "THE WORLD'S CLEANEST PAINTSHOP"

Carbon dioxide emissions at the Volvo Trucks cab factory in Umeå are to be reduced to zero. This target is to be attained by phasing out liquid petroleum gas and by taking cooling from an underground glacial river. Large investments have been made in the paintshop, which Volvo calls "the world's cleanest paintshop". They are now going further with an ambition to become even better with regard to emissions with an environmental impact.

The Volvo Trucks paintshop in Umeå has been modernised several times in recent years. Each time the paintshop has been reconstructed the company has made efforts to improve the efficiency of production, so that consumption of paint and solvents has been reduced. As a result, emissions to the air have been substantially lowered. In 1988 solvent emissions to the air totalled around 70 grams per square metre of cab surface area. Today emissions are below ten grams, which is well below the EU limit.

Volvo Trucks is making a great effort to improve the efficiency of energy use, and its target is to be a carbon-neutral factory with locally produced energy within two years.

Halving of LPG consumption

Of the 106 GWh used up by the Umeå factory in 2008, 13 percent was still LPG, yet consumption of LPG has been halved since 2006. The LPG for the paint ovens has been replaced by district heating, and today LPG is the only fossil fuel used. District heating has also replaced oil in heating, and it has

Volvo Lastvagnar

been possible to reduce CO_2 altogether by 8 000 tonnes per year. Today a quantity of energy of the order of 80 GWh per year is recovered.

Cooling from glacial river

The most spectacular energy saving is the cooling in the factory. An underground cold glacial river runs from Vindelåsarna to the Ume Älv river, not far from Volvo in Umeå. The water runs inside an esker and maintains a fairly constant, cold temperature in

Volvo Lastvagnar

summer and winter. A hole has been bored down to this underground glacial river to utilise the cooling before the water flows into the Ume Älv. Cold water from the glacial river is pumped through a two kilometre long pipe to the Volvo factory, where it is connected to the factory's own system of pipes. The cold water can then be used in various internal cooling systems. The first cooling from the glacial river was released into the factory about a year ago, and the cooling power they obtain is equivalent to 3 000 kilowatts. This glacial river cooling has replaced many items of refrigeration machinery using refrigerants such as freons in the cab factory. The new priming and top-coating paintshops use glacial river cooling to cool both processes and premises.

Project "Glacial River Cooling" has been developed by Volvo Trucks in cooperation with the water company of the Municipality of Umeå, UMEVA. The project signifies an environmental improvement and large cost savings in both investments and operation.

Other energy-saving measures are the installation of energy-efficient electric motors, frequency control of fans and pumps, demand control of lighting in the premises and the electrical installation being optimised to reduce losses, reactive power, in the electrical network. The electrical energy is locally produced and renewable, from hydropower in the Ume Älv river.

MOBILE NETWORK POWERED BY SUN AND WIND

A major problem in the expansion of mobile networks in developing countries is the lack of a reliable energy supply. Flexenclosure's E-site uses wind power combined with photovoltaic cells instead of traditional diesel generators. By using sun and wind we can sharply reduce costs and environmental impact. With E-site diesel consumption falls to a fifth, and the total operating cost is reduced by more than 80 percent.

Flexenclosure

Present-day mobile operators solve the lack of reliable energy supply and sometimes the total absence of electrical networks in developing countries by building telecom sites with power supply from one or two diesel generators. It is calculated that the telecom industry emits around 50 tonnes of carbon dioxide per site per year, which leads to extensive adverse environmental effects. In addition operating costs are very high because of the consumption of diesel, transport, refuelling and wear on the diesel generator. These factors taken together mean that the average operating cost of a diesel-powered telecom site in Africa is USD 50 000 per year.

It sometimes happens that expansion of mobile networks comes to a halt because the operating cost per site is so high. The potential from mobile users quite simply does not cover the costs as average income per user is very low in the developing markets. Flexenclosure's E-site offers completely new ways for operators to tackle the problem.

Function

The energy in the E-site site is generated by a wind generator and photovoltaic cells. Most of the energy comes from the wind generator, as wind power is the most cost-effective way of generating energy. E-site makes use of low-wind generator developed in-house which generates energy even in very light winds and is based on annual average wind speed of 3.5 m/s. In addition, E-site is supplied with solar panels, the number and size of which is dictated by local conditions. All the energy generated by the renewable energy sources is stored in a battery bank, which in turn feeds the base station with energy. The batteries are activated when the energy supply from sun and wind is not sufficient. If the batteries run out, there is a small internal diesel generator which guarantees that there will always be sufficient energy for the base station to operate without interruption.

E-site is also extremely efficient with regard to energy use. The solution makes use of two different climate zones for cooling of the telecom equipment and the batteries.

E-site is controlled by the Diriflex control system. All the energy flows and components in the solution are controlled by the Diriflex system. It is Diriflex that makes it possible to run an E-site in such an energy-efficient way and that ensures a very long service life for the site.

FOUR METROPOLITAN REGION – INDUSTRIAL ECOLOGY IN PRACTICE

Fourth Metropolitan Region is one of a small number of examples in the world of industrial ecology implemented on a large scale with renewable energy sources as a driving force. The region has been working for many years to integrate and close cycles and in various ways to view waste as a resource in terms of energy and material content. This work has resulted in a large number of interwoven cycles, all of which are run on a commercial basis.

The eco-industrial system branches geographically and technically in the Fourth Metropolitan Region, the core of which consists of the twin cities of Linköping and Norrköping. The region has a population of nearly half a million, and municipal managements, industry and universities collaborate actively to create a solid basis for the establishment and development of new businesses.

Work on eco-industrial symbiosis has shown that new jobs are being created in both large and small companies, as well as in new and traditional sectors. A large number of local or locally represented companies in the region are involved in building up the various facilities in symbiosis.

Waste is turned into heating and electricity

The co-generation plants in the Fourth Metropolitan Region almost exclusively use renewable fuel in the form of wood waste from forestry, wood waste from the building sector, household waste, rubber tyres and other combustible waste. Steam that generates electricity in steam turbines is produced from this.

When the steam has passed the turbines it needs to be cooled down to then be returned and heated up again in the co-generation plants' boilers. The more the steam is cooled, the more efficient the plant becomes. As more than 90 percent of households, offices and industrial sites are connected to the district heating network, this can be used to cool down the residual heat from the co-generation plant. For the connected properties this means a reliable and competitive heat source, based almost entirely on renewable fuel. The residual heat generates revenue for the co-generation plants.

From steam to organic fertiliser

From one of the co-generation plants steam is also supplied to an ethanol factory where the steam represents the principal energy source. In this factory ethanol is produced, by fermentation and distillation, from regionally cultivated cereals.

The ethanol factory produces 80 percent of the ethanol which in Sweden is blended with ordinary petrol (low blend 5 percent).

The principal residual product from ethanol pro-

Linköpings kommun/Norrköpings kommun

> It is intended that fuels used in public transport in Östergötland will be mainly renewable fuels by 2015.

duction is called stillage, which in an integrated feed factory is turned into protein-rich feed pellets used as a base in the production of animal feedstuffs.

Part of the stillage (around 10 percent) is used as raw material in the nearby biogas plant, where it is digested. The residual product from this biogas production is an organic fertiliser. It is sold to the agricultural sector, where it is used as a fertiliser and reduces the use of commercial fertiliser. A third of the quantity of incoming cereals is turned into ethanol, a third into feed pellets and a third into carbon dioxide. The carbon dioxide is already part of the cycle on Earth and therefore does not add any further carbon dioxide to the atmosphere. The ethanol factory has an energy factor of 1:5 and is regarded as the world's most efficient cereal-based ethanol factory. In addition to the biogas produced by the ethanol factory stillage, biogas is produced in the region from organic waste from the food industry and restaurants, as well as from sewage sludge.

Fat is turned into biodiesel

Used fat, for example from restaurants, is collected in the region. The frying oil from several hamburger restaurants is taken and processed into biodiesel. This is then used for heating and as a vehicle fuel. The residual glycerol, which is an excellent raw material for biogas production, is obtained from biodiesel manufacturing.

Agriculture produces the cereals used by the ethanol factory, uses the organic fertiliser from the biogas, buys animal feeds partly based on protein pellets from the ethanol factory, supplies livestock for slaughter, runs tractors on biodiesel and uses residuals as fertiliser for the production of biogas. Many of the cycles are closed in agriculture.

Environmental benefits in transport

In the Fourth Metropolitan Region biogas is used to run most public transport in town centres. This has resulted in lower emissions of carbon dioxide and particulates and consequently a better urban environment. It is intended that fuels used in public transport in Östergötland will be mainly renewable fuels by 2015. In Linköping 7 percent of all vehicle fuel is already biogas. Carbon dioxide emissions in the region have decreased by 20 percent since 1990. A contributory factor in this is that most of the refuse trucks that collect the waste that goes for the production of electricity, heating and steam run on biogas. More and more taxi-drivers, tradespeople and private motorists are now going over to biogas vehicles, evident in the growth rate for biogas sales in the region of no less than 36 percent in 2008.

During its EU Presidency, Sweden will be arranging several informal ministerial meetings with a common topic: an eco-efficient economy. The Ministry of Enterprise, Energy and Communications and the Ministry of the Environment are responsible for the informal energy and environment minister meetings in Åre on 23–24 July and 24–25 July 2009. The subsequent informal meeting of competitiveness ministers in Umeå on 14–16 October 2009 has the same overarching theme.

In addition to the informal ministerial meetings, the following conferences have the same overarching theme:

- "European Cities and the Global Climate Challenge", Stockholm 14–15 September.
- "Future road transport – safe and clean", Göteborg 26–27 October.
- "Eco-Efficient Economy – Towards innovative and sustainable competitiveness", Linköping 2–3 November

The issue of an eco-efficient economy will also be raised at the UN climate change conference in Copenhagen 7–18 December.

Sveriges ordförandeskap i Europeiska unionen
Swedish Presidency of the European Union
La Présidence suédoise de l'Union européenne