



# GREENTECH

THE SWEDISH EXPERIENCE & EXPERTISE



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Sweden

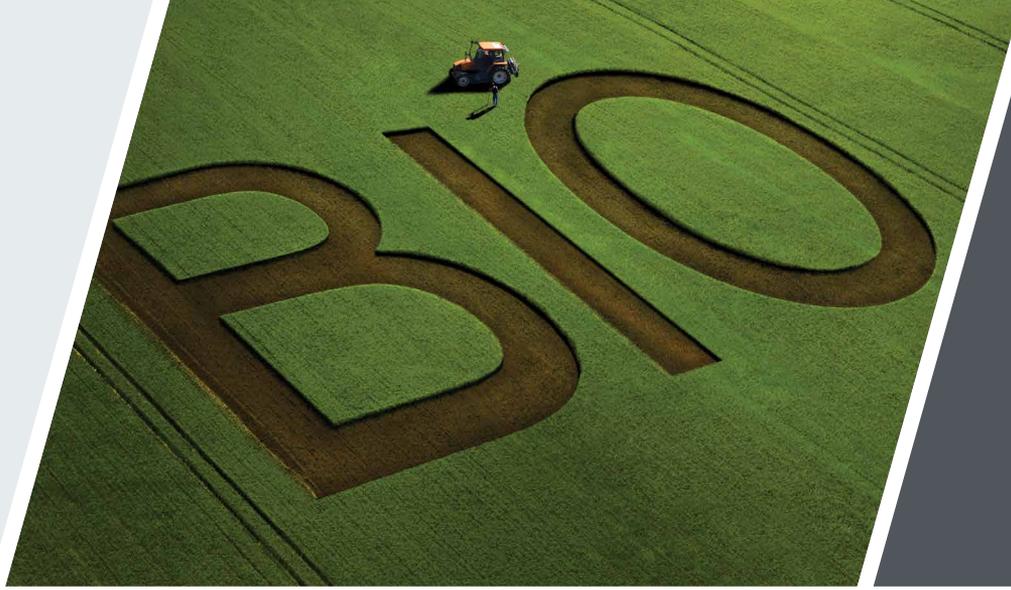
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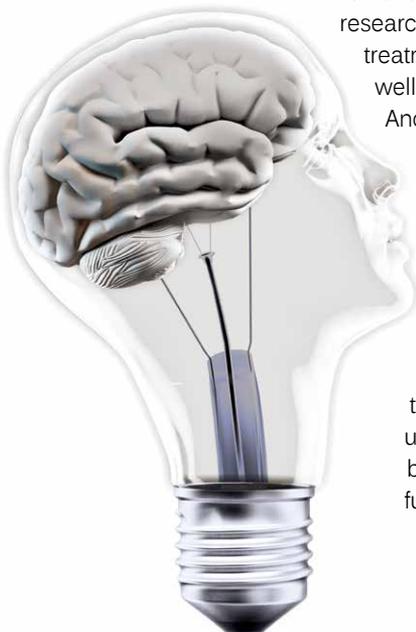


## INTRODUCTION

Sweden is one of the world's leading nations innovating, implementing and exporting Green Technologies, commonly known as Greentech or Cleantech, which lie at the heart of environment-friendly sustainable development and are moving up on the global socio-economic development agenda at a rapid pace.

Sweden has been proactively pursuing and practicing policies that have encouraged research and development in water purification, sanitation, sewage and wastewater treatment, waste management and waste-to-energy, production of biofuels, as well as generation of renewable energy from wind, biomass and solar power. Another strong growth area within the green technologies sector in Sweden is clean industrial production to protect and preserve the environment, as well as eradicate the waste of vital material and human resources.

The continued push towards the development and implementation of green technologies has enabled Sweden to become the first country in Europe to meet the renewable energy targets, set by the European Union (EU) for 2020, eight years ahead of schedule. Renewable energy accounted for 49.6 per cent of total energy used in Sweden at the end of 2012 and its share is set to exceed 52 per cent in 2013 (see table). The EU target calls for renewable energy making up for 49 per cent of the total energy used in member countries, reducing emissions of greenhouse gases (GHGs) by 20 per cent and ensuring that biofuels account for 10 per cent of total auto fuel consumption by 2020.





## Sweden power production 2011/2012

Production	2011 (TWh)	2012 (TWh)	% change
Hydropower	66.2	78	17.8
Wind	6.1	7	14.8
Nuclear	58	60.9	5
CHPs	16.6	15.4	-7.2
<b>Total</b>	<b>146.9</b>	<b>161.3</b>	<b>9.8</b>
Exports	7.2	19.6	172.2

Source: Swedenergy

### Higher Clean Energy Output

Production of clean renewable energy is continuing to rise in Sweden. Total power production increased by 9.8 per cent in 2012 to 161.3 TWh from 146.9 TWh in 2011 due higher than average hydropower output, which went up by 17.8 per cent to 78 TWh from 66.2 TWh in 2011, nuclear power production recorded a 5 per cent increase to reach 61 TWh compared with 58 TWh a year earlier, while wind power production increased by 18 per cent to 7.2 TWh from 6.1 TWh in 2011.

Power production from combined heat and power (CHP) plants – which use biomass and waste as feedstock - went down by 7.2 per cent due to a mild weather during 2012 to 15.4 TWh from 16.6 TWh in 2011. Total electricity consumption in Sweden in 2012 went up marginally by 1.4 per cent to 142 TWh from 140 TWh in 2011, primarily due to milder weather in the fall and a slowdown in the use of electricity by the industrial sector. Higher production of renewable energy saw Sweden's power exports rising by a record 172.2 per cent in 2012 to 20 TWh from 7 TWh in 2011. Due to higher exports from Sweden, the Nordic region exported 15 TWh in 2012 to the rest of Europe compared with imports of 5 TWh in 2011.

Sweden's successful experience and knowledge of implementing green technologies could be used by many countries around the world, especially in the developing world, where the challenges of developing a sustainable civic and industrial infrastructure in line with the needs and demands of a growing population must be overcome to realise economic growth in the short, medium and the long term. They could also benefit from emulating how Sweden is continuing to develop its economy and human resources without neglecting the environment.

Green technologies are being used in Sweden across all sectors in a sustainable manner and there is a strong correlation between economic growth and reduction in waste, greenhouse gases, making optimum use of natural and human resources, and the production and conservation of energy through ongoing innovation to meet the environmental and human development challenges in a changing world. Using green technologies could bring many tangible and intangible benefits to developing countries, and Swedish companies could certainly play a positive role in helping them overcome their sustainable development and economic growth targets and objectives.



# Bio-Diesel

## BIOENERGY

Bioenergy is produced from biomass sourced from forestry and agriculture and in Sweden peat is also an important source of bioenergy. Forest and agricultural products could be harvested for direct delivery to energy production and the cultivation of these energy crops is growing at a rapid pace. Harvest by-products such as forest residue - branches and tops - stumps or straw, and unused products from traditional industries, burning lye in the paper pulp industry, as well as pellets of lignin or cereal residue are also used to produce bioenergy.

Biofuels can be divided into unprocessed solid fuels, raw fuels such as wood chips, sawdust, crushed bark and bundled forest residue. Processed solid fuels include wood pellets, briquettes and powder. Bio-oils are burned in oil or powder burners. Rotting slaughterhouse waste is used to produce biogas.

### Major Advantages

Bioenergy offers some major benefits including reduction of carbon dioxide emissions, and reduces dependence on imports of fossil fuels. Additional economic benefits of bioenergy include emissions reduction allowances and electricity certificates. The bioenergy industry increases local labour needs and creates employment opportunities. Local fuel supply is more secure, as forest fuel, waste and agricultural by-products reduce long-term energy costs, are often readily available and provide logistical advantages.

### The Swedish Biomass Experience

For Sweden, biomass was the major source of energy before the industrial revolution and its use has now more than quadrupled from 40TWh/yr in the 1970s. Today, biomass plays a major role in meeting the district heating requirements in Sweden and is also the main source of energy for the energy-intensive forest industry. Electricity produced from bioenergy accounts for more than 9 per cent of total electricity produced in Sweden, and enabled the country to reduce its Greenhouse Gas Emissions (GHGs) by 9 per cent from 1990-2010 when the Gross National Product (GNP) increased by 50 per cent.

Sweden's bioenergy sector has been driven by political support and incentives such as the carbon tax, introduced in 1991, and the green electricity certificate system, put in place in 2003 by the government, as well as a tax exemption for biofuels for the transport sector. Sweden



is now well on its way to exceed the EU's target of using 10 per cent of environment-friendly biofuels in the transport sector by 2020.

Swedish greenhouse gas (GHG) emissions declined by 5 per cent to 58.3 million tonnes CO<sub>2</sub> equivalent (CO<sub>2</sub>e) in 2012 compared with 2011, on mild weather and higher rainfall, which boosted hydropower output to record levels. Emissions were down by 20 per cent compared with baseline year 1990, according to preliminary data released by the Swedish Environmental Protection Agency.

Road transport emissions fell by 4 per cent on the year to 17.9 million tonnes CO<sub>2</sub>e, but were slightly above the 1990 level. Emissions from energy industries — such as producers of power, district heating and solid fuels, and refineries — dropped by 5 per cent on the year to 10.7 million tonnes CO<sub>2</sub>e, but were about the same as the 1990 level. Industrial emissions fell by 8 per cent to 13 million tonnes CO<sub>2</sub>e from 2011, and were 22 per cent lower than in 1990.

Emissions from domestic transport such as boats, industrial vehicles and machinery decreased by 10 per cent to 4.8 million tonnes CO<sub>2</sub>e, and were 12 per cent lower than in 1990. Emissions from energy used in buildings, homes and agricultural industries increased by 2 per cent to 1.8 million tonnes CO<sub>2</sub>e, and were lower by 81 per cent than 1990 levels, mainly because of an expansion of district heating and a shift from oil to biofuels.

Agricultural emissions fell by 2 per cent from 2011 and 16 per cent from 1990, to 7.6 million tonnes CO<sub>2</sub>e, and those from waste declined by 9 per cent to 1.6 million tonnes CO<sub>2</sub>e. Fugitive emissions — including leaks from equipment, emissions from bulk handling, extraction or processing of raw materials, and other industrial processes - such as dry cleaning, paint thinners, detergent, polish removers - decreased marginally to 1.3 million tonnes CO<sub>2</sub>e. Emissions from international marine bunkering fell by 3 per cent to 8 million tonnes.

### **Biomass-fired Combined Heat & Power (CHP) Plants**

Swedish CHPs have been replacing oil with biomass as fuel to run their operations since the 1980s, and most of them now run on biomass except when they have to meet peak demand in case of a severe winter. There are now 84 Combined Heat & Power (CHP) plants for district heating in Sweden with total installed capacity of 2,571.65MW. Of these, 20 units, with an installed capacity of 465MW, use municipal waste.



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A few plants use both municipal waste and biomass, and the total number of biomass plants is around 70 which use all kinds of sustainable fuels, such as wood pellets, black liquor, tall oil, bark, sawdust, wood chips, forest residues, recycled wood, biofuels and agricultural biomass. A couple of plants have combined use of fossil fuels and biomass. In district heating there is capacity of 1,319.47MW installed almost entirely in the forest industry. The current electricity production of 6TWh/yr at CHP plants is almost as high as district heating because of the longer production time throughout the year.

The CHPs only run in the heating season from October to April while the forest industries produce power all year around, with a short break in the summer vacation period for maintenance. There are also 59 plants producing electricity from biogas with total installed capacity of 18.89MW. Biomass now accounts for 32 per cent of the total energy produced and more than seven per cent of total electricity produced in Sweden. The use of bioenergy in district heating has grown from almost zero in the 1970s to 75 per cent of total fuel used.

In 2000, total biomass used in Sweden's energy mix stood at 100 TWh/yr, which increased to 127 TWh/yr in 2009 and to 141 TWh/yr in 2010 owing to a very cold winter. The mild winter in 2011 saw total use of biomass at 132 TWh/yr, and stood at around 138 TWh/yr at the end of 2012. Sweden usually measures feedstock in energy terms. The statistics do not separate CHPs and other heat plants but do distinguish between fuels used for electricity production and fuels used for heat production.

In 2011, biomass fuels used for electricity production in Sweden were 12.19TWh, waste 2.54TWh and peat 0.79TWh. These numbers include both CHPs and plants in the forest industry. Practically all waste and peat are used in CHPs and about 60pc of biomass is used in industry and 40pc in CHPs. In 2011, biomass fuels used for heat production were 28.65TWh, waste 12.27TWh and peat 2.14TWh. Sweden is set to bring online 39 new CHP plants by 2017, and many of them will be built next to existing plants and will be larger and more modern.

### Wood Pellets

Sweden's total wood pellets consumption declined by 9.7 per cent to 1,699,800 tonnes in 2012 from 1,882,500 tonnes in 2011 mainly due to a mild weather. There are now a total of 70



pellet plants in operation in Sweden. Total production decreased by 11.2 per cent to 1,171,685 tonnes from 1,319,789 tonnes in 2011 due to lower consumption at home and a depressed demand for exports, which went up only marginally by 1.3 per cent to 128,506 tonnes from 126,806 tonnes in 2011. The mild weather also had an impact on imports, which went down by 26.2 per cent to 490,686 tonnes in 2012 from 665,415 tonnes in 2011.

In 2012, about 8.4TWh/yr of energy was produced by using pellets as feedstock, up 3.7 per cent from 8.1TWh/yr in 2011, which was 5.8 per cent less than the 8.6TWh/yr produced in 2010. One tonne of pellets produce 4.8MWh of energy. Sweden has pellet-handling facilities at five ports, which include the Stockholm bulk handling port in central Sweden, Karlshamn in Goteborg on the West Coast, the Port of Varberg in the southwest, Hargshamn in Uppsala near Stockholm, and Oxelosunds in the southeast.

### **Swedish CHP Technology**

Many Swedish companies have developed efficient medium-sized heating and power plants with capacities ranging between 0.3MW-25MW to produce electricity and heat for industrial and district heating. These plants provide district heating to local communities and heat for producing hot water. Industrial applications for heating, hot water, steam and processes are also on the rise and small CHPs are being built at a rapid pace. The Swedish CHP experience could be emulated, especially in developing countries where large quantities of municipal waste, forest waste, and energy crops are produced but are not being used in a productive and environment-friendly manner.

Swedish companies could provide technologies for setting up CHPs that could use a variety of fuels, which vary depending on their availability in local communities. Wood pellets could be used for plants with capacities of 0.3MW-2MW, dry wood chips and sawdust for plants between 0.3MW-3MW, moist wood chips and bark for 0.5MW-25MW plants, and waste for plants with capacities of 15MW and above.



## BIOENERGY

### Bioenergy solution providers in Sweden:

- Swedish Bioenergy Association (Svebio) <http://www.svebio.se>
- Business Region Goteborg <http://www.businessregiongoteborg.com/huvudmeny/clusters/businessenvironment/ecoex/companydatabase/energy.4.209e6e8712be26ef9658000310.html>
- ALLAN BRUKS <http://www.allanbruks.se/en/>
- SweHeat & Cooling <http://sweheat.com/>
- Svensk Biogas <http://www.sevenskbiogas.se>
- CHEMREC <http://www.chemrec.se>
- Filcon <http://www.filcon.se>
- ROLAND CARLBERG <http://www.rcprocess.se>
- eXERGY <http://www.swedishexergy.com>
- Jernforsen <http://www.jernforsen.com>
- PEAL <http://www.peal.se>
- SenSic AB <http://www.sensic.se>
- MOGENSEN <http://www.mogensen.se>
- Ekman <http://www.ekmangroup.com>
- OPCON <http://www.opcon.se>
- KMW ENERGI <http://www.kmwenergi.se>
- MACON <http://www.macon.se>
- PST <http://www.pst.se>
- Lantmannen <http://www.agroenergi.se>
- MW Power <http://www.vea.se>
- HOTAB <http://www.hotab.se>
- BooForssjo <http://www.booforssjo.se>
- COWI <http://www.cowi.com>
- MEVA Innovation AB <http://www.mevagroup.se>



### Suppliers of 0.3MW-25MW combustion plants

- Ecotec Värmesystem AB <http://www.ecotec.net/index2.html>
- HOTAB Eldningsteknik AB <http://www.hotab.se/default.asp?pid=17>
- Janfire AB <http://www.janfire.com/eng/index.htm>
- Järforsen Energisystem AB <http://www.jernforsen.com/en>
- KLM Energi & Mekanik AB <http://www.klmenergi.se/www/index.html>
- KMW Energi AB <http://kmwenergi.com/>
- Osby Parca AB <http://www.osbyparca.com/>
- PetroKraft AB <http://www.petrokraft.com/>
- Saxlund International AB [http://www.opcon.se/web/Opcon\\_Bioenergy\\_EN.aspx](http://www.opcon.se/web/Opcon_Bioenergy_EN.aspx)
- Swebo Bioenergy AB <http://www.swebo.com/foeretag.html?L=1>
- WTS AB <http://www.wtsab.com/>

### Biofuel producers and suppliers in Sweden

- Lantmännen Energi AB <http://lantmannen.com/en/Sectors/Energy-sector/>
- Mellanskog <http://www.mellanskog.se/Kontakt/Press/In-english/>
- Neova AB <http://neova.se/sv>
- SCA Norrbränslen AB <http://www.sca.com/en/skog/biofuel/facts-about-sca-norrbranslen/>
- Skellefteå Kraft AB <http://www.skekraft.se/Privat>
- Sveaskog AB <http://www.sveaskog.se/en/>
- Södra Skogsenergi AB <http://www.sodra.com/en/About-Sodra/Our-business-areas/Sodra-Skog/Sodra-Skogsenergi-AB/>
- Derome Bioenergi AB <http://www.deromepellets.se/>

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## SOLAR ENERGY

Limited exposure to sunlight in the cold and dark winter months in Sweden has not discouraged Swedish companies from developing unique and innovative solar energy technologies that provide the world's highest energy gain through the use of high quality materials and secured processes. Swedish solar energy companies have taken the lead in developing the next generation of energy solutions and are capitalising on the opportunity to introduce innovation and modern technologies to a young industry that has a bright future ahead of it.

Sweden has some of the most automated factories in the world, which are at the forefront in the development of photovoltaic modules. These modern factories are developing a clean, natural energy option for the benefit of current and future generations through on and off-grid power generation solutions. Many original equipment manufacturers (OEMs) in Sweden have been working for over a decade on product development and are now seeking and building partnerships and re-seller networks around the world.

Swedish solar technologies are enhancing the positive contribution made by renewable and environment-friendly solar energy solutions that are reducing the energy payback time and the negative environmental impact by constantly evaluating their processes and products to optimise the use of resources, preventing pollution, reusing, recycling and recovering material to minimise waste.

Solar modules produced in Sweden are designed for various markets and applications. High quality production combined with stringent process control systems ensure maximum lifespan and the highest performance, while the robust construction of equipment is resistant to extreme heat, heavy wind and snow load. Swedish solar modules give 5-8 per cent higher energy yield performance during scattered and low light conditions, especially in the morning, evening and in the winter months and maintain the high energy yield over a long period of time.

### **On, Off-Grid Solar Systems**

Swedish solar energy companies provide turnkey solutions for the development of solar parks that promote ecological energy and improve energy efficiency through smart crossover solutions with 25 years of power output warranty. Sweden provides major solar plants ranging from 1.25MW-100MW. Many Swedish companies commission the larger plants in collaboration with the world's leading power distribution and transmission companies such as ABB and



local partners in host countries. Inverters, transformers and grid connection systems are often sourced from ABB for medium-size solar plants of 100kW–1MW, installation and grid connections are undertaken through local partners, while extensive training is provided for the staff of local partners.

Public sector institutions and organisations in developing countries are being offered solar parks and plants of 1.25MW and above, individual and corporate consumers of energy are being offered solar plants ranging from 100kW–1MW. The typical users of such plants are factories, hospitals, universities, sports clubs, hotels, office and residential buildings, gated residential communities, as well as shopping malls and mixed-used buildings in remote areas, small towns and major cities. The solar energy solutions being supplied by Swedish companies include plants that can generate electricity, heat or a combination of both, and plants that are also capable of meeting the electricity, heat and air-conditioning needs of individual housing units and commercial buildings.

### **Solar Power For Water Purification**

Swedish companies have developed superior life supporting solar-powered water purification and desalination systems that are becoming increasingly useful as an integral part of the push to procure clean drinking water in developing countries by international, regional and local emergency relief agencies, local governments, corporations, non-government organisations (NGOs), as well as private home owners who need small and reliable systems that are easy to operate.

These environmentally friendly power solutions need no external power or use of any fossil fuel and offer outstanding and creative systems and solutions, increased flexibility, and greater value that optimise system functionality and improve operational efficiency. Swedish solar-powered desalination systems eliminate salt from the water and provide clean, safe drinking water based on the reverse osmosis system and a proven and reliable filtration method that removes unwanted large molecules and ions from the water. The systems are scalable to meet higher consumption demands for institutions such as hospitals, schools, small villages, factories, poultry and dairy farms and could provide up to 100 litres per hour of clean water.

Another range of Swedish solar-powered water purification systems clean water without



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any chemicals and are run by a solar panel. The system eliminates 99.9 per cent of all bacterial and viral contaminants to provide clean and safe drinking water. The system comprises a photovoltaic energy power station with 12V output and a water purification system. The photovoltaic system also provides clean reliable electrical power for charging mobile phones, radio and rechargeable electrical lights. The system is scalable from a set-up with one solar panel requiring virtually no installation, to high capacity systems meeting the consumption demands of villages, schools and hospitals. This mobile system has capacity to supply 600 litres of clean water per hour.

Sweden has also developed a unique portable solar-powered water purification solution for peacekeeping forces and emergency relief teams who require a lightweight, mobile, robust and reliable water purification system. The portable water purification system, which can be carried on the back, has the same utility as the other systems and comes with a foldable solar panel. The system has capacity to produce up to 300 litres per hour of clean drinking water.

### Swedish solar energy companies:

- Swemodule <http://www.swemodule.se>
- Solarwave AB <http://www.solarwave.se>
- Solarus <http://www.solarus.se/>
- Absolicon <http://absolicon.com>
- CleanEnergy <http://www.cleanenergy.com>
- Windon <http://www.windon.se/en/>
- HiNation <http://hination.com>
- S Solar <http://en.ssolar.com/>

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## WASTE MANAGEMENT & WASTE-TO-ENERGY

Sweden has an effective waste management system in place and landfill of municipal waste is almost non-existent. About 99 per cent of the household waste is recycled as energy or material. A recent survey on how waste is used for energy recovery from a European perspective showed that Sweden extracts the most energy from waste combustion. Sweden's vision of having 'zero waste' by 2020 permeates all levels of waste management and collection of source-separated food waste is on the rise. About 60 per cent of Swedish municipalities now have collection systems for source-separated food waste and another 70 municipalities are planning to put similar systems in place.

### Stringent Waste Management Regulation

The Swedish parliament decides how Swedish waste management should be structured. In the 2000s the environmental goals set by the parliament steered Sweden towards greener waste management practices, and the country's municipalities have played a key role in achieving those objectives. A shining example is the minimisation of landfill as a treatment method for managing household waste. The use of landfill decreased to less than 1 per cent in 2011 from around 5 per cent in 2005 and continued measures are being undertaken to further minimise this practice.

In May 2012, the Swedish government set new targets for waste management, which call for the implementation of measures that could ensure that by 2018 at least 50 per cent of food waste from households, large-scale kitchens, stores and restaurants is separated and treated biologically to recover plant nutrients, and at least 40 per cent is treated to produce energy. By 2020, at least 70 per cent of construction and demolition waste should be prepared for reuse and material recycling.

Waste management in Sweden is geared towards achieving the maximum environmental and social benefits and encourages all stakeholders including product manufacturers, distributors, marketers, other businesses, municipalities and households to play a proactive role in the process. Swedish municipalities are responsible for household waste, producers for their respective product groups and enterprises for handling all non-household waste. All households in Sweden have an obligation to separate and deposit waste at dedicated collection points and to comply with municipal waste management regulations.



## Prevention Is Better Than Cure

Waste prevention is the first step in the waste hierarchy and receives high priority in Swedish waste legislation. The environmental benefit of a product is greater if it is never produced than if it is produced, used and recycled. In 2011, Sweden adopted the long-term vision of producing 'zero waste' by 2020 to break the relationship between waste quantities and economic growth with the municipalities playing a key role in guaranteeing sustainable waste management.

There are several good examples of municipalities successfully reducing quantities of waste. The Alelyckan Recycling Park in Gothenburg, on the West Coast of Sweden, prevents 360 tonnes a year of waste from being generated by recycling products instead of discarding them. Gavle municipality, north of capital Stockholm, runs a 'Sustainable Families' project where several families have to adopt a greener lifestyle for one year. One of the project's assignments is to reduce waste and, on average, each family produces 3kg less waste per month during the course of the project.

Another good example is the inter-school competition organised by the Halmstad municipality, in the south of Sweden, to reduce the most food waste during the European Week For Waste Reduction programme, which started in 2009 and runs until 2015. The programme has, to date, resulted in an 11 per cent decrease in food waste. Educating the younger generation about waste reduction brings long-term benefits that include optimum utilisation of resources.

## National Waste Management Plan

Promoting the reuse of household waste is one of the major goals of Sweden's national waste management plan. The plan focuses on making it simpler for people to deposit waste material and products for reuse or for preparation for reuse. Household waste can be collected in bins and bags either as a mixed fraction intended for waste-to-energy recovery or in separate fractions – one for food waste and one for combustible waste.

Most Swedish municipalities provide curbside collection of packaging and newspapers from apartment blocks. About 30 municipalities also provide the same service for single-family houses. Packaging and newspapers are commonly separated into two four-compartment bins, which are collected at different intervals. One bin is designated for food waste, combustible waste, paper packaging or coloured glass is emptied every fortnight. The other bin is designated for clear glass, metal, plastic packaging or newspapers and is emptied every four or eight weeks.



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Traditional rear-loading vehicles continue to be the predominant transport for waste collection, but the proportion of multi-compartment vehicles is growing and becoming more technically advanced. Side-loading vehicles account for a more steady proportion of the Swedish waste collection vehicle fleets. Clean alternative fuels and various hybrid technologies are used to reduce the climate impact of vehicles. A rising number of vehicles use biogas as fuel, which municipalities can control through their procurement requirements.

Mixed combustible waste from single-family houses in Sweden is mostly collected in 190-litre bins that are emptied every fortnight. There are also a number of different bag and bin sizes, which are emptied at different intervals. Waste from apartment blocks is usually collected on a weekly basis, while the most common collection system for source-separated food waste is in separate bins - one for food waste and one for combustible waste - and multi-compartment bins or by optical sorting.

### Waste Collection In Sweden

In 2011, total household waste collected in Sweden stood at 4,349,910 tonnes, up 3.5 per cent from 2010. Swedes on average produced 458.7kg per person of household waste in 2011, compared with 443.3kg per person in 2010. Biological treatment of waste increased by 4.3 per cent to 650,300 tonnes or 68.6kg per person, and 14.9 per cent of household waste went for biological treatment. Collection of food waste increased by 10 per cent to 275,000 tonnes.

Food waste that went to joint anaerobic digestion plants went up by 28 per cent, while food waste sent to central composting plants decreased by 24 per cent. Total food waste undergoing anaerobic digestion at waste treatment plants stood at 65,000 tonnes in 2011. Home composting of food waste in Sweden is declining as more municipalities are introducing centralised food waste collection.

Quantities of waste collected in bins and bags increased to 2.2 million tonnes in 2011, down 3.6 per cent from 2010. Collection of hazardous waste increased by 16 per cent to just under 60,000 tonnes. Half of the hazardous waste consists of impregnated timber, which goes to incineration. Impregnated timber accounts for a large proportion of this increase.



## Waste Collection Methods

### Optical Waste Sorting

Optical sorting requires households to separate waste into bags of different colours that are placed in the same bins. These bags are transported in a waste collection vehicle to an optical sorting facility where they are separated automatically for appropriate treatment. Many Swedish municipalities have introduced optical waste sorting systems for food waste, paper packaging, newspapers, metal packaging, plastic packaging and other household waste.

### Vacuum Waste Collection

Manual waste handling in Sweden is being replaced by automated systems such as vacuum collection and underground container systems. These systems are becoming more prevalent, particularly in large cities and newly built-up areas, and require minimum heavy manual handling. Vacuum refuse collection is not exposed to open air and is fully automated. It is a good system from a work environment perspective and reduces the need for transportation, particularly inside residential areas.

**There are two types of vacuum waste collection systems in place in Sweden:**

#### ■ Stationary Vacuum Waste Collection

With the stationary system, waste is collected by air into an automatic vacuum system and is transported through underground tubes that connect the waste drop chutes to large containers that are placed in a terminal. With this technology, waste can be transported up to two kilometers from the drop chute. The number of containers used depends both on the number of separated fractions, and on collected waste quantities. The containers are collected by load carrying vehicles.

#### ■ Mobile Vacuum Waste Collection

A mobile vacuum collection unit is located inside a special purpose vehicle. The system also uses air to collect waste and a storage tank is positioned under each drop chute. The



## WASTE MANAGEMENT & WASTE-TO-ENERGY

storage tanks are connected through an underground pipe system that leads to a docking point and can be placed at a distance of up to 300 metres from the tanks. The vehicle connects to the docking point for emptying. When the vacuum system is switched on, air propels the waste from the storage tanks to the docking point and into the vehicle.

### Underground Container Systems

Underground containers carry larger volumes and reduce transportation requirements. They also reduce the need for space at street level, and are a growing waste collection method in Sweden. The temperature below street level, where the waste is contained, is relatively low and this prevents foul odour and the containers could easily be emptied with a hook-lift vehicle. Front-loading vehicles are also used to empty underground containers.

### Waste Recycling Centres

Households can drop off bulky waste, electronic waste and hazardous waste at manned municipal recycling centres. Bulky waste is household waste that is too heavy or inappropriate for collection in bags or bins. In 2011, Swedish households dropped off bulky waste equivalent to 173kg per person. The municipal waste recycling centres received a total of 1.6 million tonnes of bulky waste. A small proportion, about 10 per cent, of the waste was collected through curbside collection.

There are around 630 waste recycling centres across Sweden, which receive about 20 million visits a year. Higher standards of living and proliferation of modern gadgets have also increased the quantities of bulky waste and hazardous waste dropped off at recycling centres in recent years. Many municipalities have expanded and modernised their recycling centres, and many smaller ones are being replaced by larger centres capable of accepting higher quantities of waste and number of visitors.

### Recycling Stations

Product producers in Sweden have set up more than 5,800 unmanned recycling stations to cover the entire country's needs for handling packaging and newspapers. The producers



also design the waste collection systems for these recycling stations in consultation with their municipalities. The recycling stations have separate containers for newspapers and different packaging materials.

About 60 per cent of the contents of household trash bags can be recycled. A growing number of Swedish municipalities are introducing curbside collection of packaging and newspapers from apartment blocks and single-family houses. In households where there is no source separation of food waste, almost 80 per cent of household trash bags can be recycled. Single-family houses are generally better at separating recyclable materials and about 30 per cent of the contents of their garbage bins comprise packaging and newspapers.

In apartment blocks separation of recyclable household waste could go up to 36 per cent of total waste generated. Hazardous waste including batteries and Waste from Electrical & Electronic Equipment (WEEE) accounts for about 0.5 per cent of the contents of household garbage bins. Single-family houses with curbside collection separate waste most effectively and dispose about half the amount of packaging and newspapers in trash bags compared with other households.

### **Material Recycling**

Material recycling reduces the production and consumption of new construction materials and saves energy. By using recycled steel, one could save the same amount of virgin material and cut more than one tonne of Carbon Dioxide (CO<sub>2</sub>) emissions. The material recycling of packaging, return paper, scrap metal, WEEE and batteries also reduces their negative impact on the environment. In 2011, material recycling in Sweden stood at 1,425,690 tonnes or 150.3kg per person, up 0.8 per cent from the previous year. Around 32.8 per cent of household waste in Sweden goes to material recycling and the municipalities have systems for collecting several types of material for material recycling.

As of 2011, material recycling statistics in Sweden also include gypsum, flat glass and non-packaging plastic, also known as municipal plastic waste. Some water-based paints and oil filters, packaging and newspapers from households also go to material recycling. These fractions accounted for 757,430 tonnes or 80kg per person in 2011. Industry association Swedish Waste Management plays a major role in increasing knowledge and boost public confidence



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in material recycling and in 2010-2011 it carried out a national material recycling campaign in cooperation with Swedish municipalities.

### **Biological Treatment – Biogas From Waste**

Anaerobic digestion produces digestate, which is an excellent fertiliser with a high nutrient content. In 2011, 594,000 tonnes of digestate was produced, of which more than 90 per cent was returned to agriculture. Using digestate instead of mineral fertiliser returns nutrients to the soil, including phosphorus, which is a finite resource. The anaerobic digestion of biological waste produces biogas, which consists of methane and carbon dioxide. Biogas is renewable and can, after upgrading, be used as an environmentally sound vehicle fuel, for heating or electricity production. Compost is used mainly in soil improvement agents or soil mixes.

Biological treatment closes the eco-cycle and returns nutrients to the soil. Waste is treated via anaerobic digestion or composting. Anaerobic digestion produces digestate and biogas that can be used as vehicle fuel. Composting produces long-lasting fertiliser, which can be used as soil improver in gardens, parks and for ground installations.

Biological treatment now accounts for 14.9 per cent of the total quantity of treated household waste in Sweden. In 2011, 650,300 tonnes of household waste was treated through anaerobic digestion or composting. This is a decrease of 4.3 per cent compared with 2010. The biological treatment of food waste, excluding home composting, stood at 275,000 tonnes in 2011. Anaerobic digestion at joint anaerobic digestions plants increased by 28 per cent compared with 2010. Composting of food waste is on the decline as more food waste is being treated by anaerobic digestion.

Solid waste analyses of household waste show that single-family households generated around 90kg of food waste per person each year. For residents in apartment blocks the figure is around 100kg. This does not include food waste from restaurants, schools and similar facilities. Food waste mainly consists of fruit and vegetable residues, but a report from the national food administration shows that a large part consists of fully edible food, more than 50kg per person each year. Between 10-20 per cent of all purchased food is discarded unnecessarily and could be eaten if treated differently.



## Landfill – Handling waste that cannot be recycled

Landfill is a treatment method for waste that cannot or should not be recycled in any other way such as tiles, porcelain and crushed concrete. Landfill entails waste being stored in a manner that is safe in the long-term, while landfills of organic or combustible waste are prohibited. A total of 1,515,000 tonnes of waste was deposited at Swedish landfill sites for municipal waste in 2011, an increase of 245,000 tonnes compared with the previous year. This is partly due to an increase in the landfill of contaminated matter. Around 38,000 tonnes or 0.9 per cent of household waste went to landfill, down 9 per cent from 2010. On a per capita basis for the whole of Sweden, it represents 4kg per person.

Landfill is only part of the operation at modern waste management sites. Most sites also separate waste materials going to treatment, for transportation to reuse, recycling and energy recovery plants. Sometimes landfill sites also serve as temporary storage for large quantities of waste that fall under the producer's responsibility, such as paper, glass and waste fuel. Plants also often treat biodegradable waste and contaminated matter. Final capping of closed landfills and landfill cells can also take a long time.

On 31 december 2008, stricter EU landfill regulations took effect and almost half of all landfill sites for municipal waste were closed. In 2011, household waste was landfilled at 79 waste management plants. Most of the landfill sites that continue operating take non-hazardous waste. Landfill sites that are closed must be capped with a final cover, and the total estimated cost for the final covering of the landfill sites in Sweden is about SEK 6 billion. Each year, approximately 6-8 million tonnes of material is used for the final covering of landfill sites.

## Hazardous Waste

Hazardous waste can be toxic, carcinogenic, corrosive, toxic for reproduction, ecotoxic, infectious or flammable. Hazardous household waste in Sweden is regulated by the Swedish environmental code, the waste collection and hazardous waste disposal ordinance and the municipal waste regulation ordinance. Swedish households have an obligation to separate hazardous waste from other household waste. Most municipalities have regulated this obligation in their municipal refuse collection regulations.



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In 2011, Swedes handed in about 6.3 kg of hazardous waste and a total of 59,830 tonnes of hazardous waste was collected from households, including 30,000 tonnes of impregnated timber and 5,450 tonnes of asbestos. The most common collection system for hazardous household waste is to hand it in at manned municipal recycling centres. Several municipalities have discontinued the unmanned recycling stations and have instead introduced some form of curbside collection. Approximately 40 per cent of all municipalities in Sweden provide curbside collection of hazardous waste, often in combination with several other collection systems.

### Hazardous waste treatment methods

Hazardous waste often requires pre-treatment to facilitate further treatment. Substances that cannot be rendered harmless or reused are taken to landfill to ensure that the waste is chemically and physically stable and hazardous substances do not leak out in the surrounding areas. Hazardous substances are separated from the waste and the remaining waste is recycled. This method is used for disposal of materials such as paint tins and oil filters.

Toxic and non-degradable substances such as pesticides and other hazardous chemical waste are incinerated in special furnaces at high temperatures. Contaminated soil can be decontaminated through biodegradation. Impregnated timber contains ecologically harmful substances such as arsenic, creosote and copper. Collected timber is chipped and incinerated in specially licensed waste-to-energy plants.

### Disposal of Batteries

Battery producers in Sweden are responsible for the collection, treatment, recycling and disposal of all batteries. Producers are also responsible for nationwide information and awareness dissemination activities on how to dispose of batteries in a safe manner. In 2011, about 2,700 tonnes of portable batteries and 500 tonnes of built-in batteries were collected in Sweden, an average of 340 grams per capita, up 16 per cent from 2010. In 2011, 6,780 tonnes of car batteries, an average of 0.7kg per capita, were collected which were 3 per cent less than the previous year.

Swedish battery producers' organisation El-Kretsen handles the collection of portable batteries in about 70 per cent of municipalities, while the remaining municipalities handle the collection as a service in exchange for an agreed compensation from the producers. All collected



batteries are separated according to their chemical content before being sent for recycling or disposal. Car batteries are sent for recycling and the lead is used in new car batteries, batteries containing nickel/cadmium are sent for treatment, where the cadmium is reused in open nickel cadmium batteries, which are used in industry.

Nickel is recycled by steel mills. Nickel metal hydride batteries are recycled, while batteries containing mercury are sent for processing. Mercury should not be recycled and is extracted from batteries so that it can be taken out of the eco-cycle and disposed of safely. Lithium batteries are taken care of wherever the cobalt can be recovered and used as an additive in the steel industry.

### **Waste From Electrical & Electronic Equipment (WEEE)**

Swedish producers of electric and electronic equipment were made responsible for the collection of WEEE through a new regulation introduced in 2001. Swedish Waste Management, the Swedish Association of Local Authorities & Regions (SALAR), and the electronic producers' organisation, El-Kretsen, have created the El-Retur system for collecting electronic waste.

Municipalities assume responsibility and receive compensation for the collection of WEEE from households, while the producers are responsible for its treatment. In 2011, a total of 149,280 tonnes of WEEE was collected, up 4 per cent from 2010. On average, each person handed in 15.7kg of WEEE in 2011, compared with 15.3 kg per person in 2010.

### **WEEE Collection**

Collection of WEEE from households is primarily carried out at approximately 630 manned municipal recycling centres throughout Sweden. In around 80 per cent of municipalities there are three or more municipally organised collection systems for WEEE. Curbside collection by municipalities or entrepreneurs covers around 1.2 million households. Collection via stores, including the electronics industry's own collection system, is available at more than 1,500 collection points.

Swedish Waste Management and El-Kretsen collaborate with several municipalities on different projects to develop these collection systems. One such system is the collection container for light bulbs and smaller items of WEEE. There are around 100 of these collection



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containers placed in stores and other public places across Sweden. The development of different recycling technologies has simplified the collection process for consumers, who can now put all their light sources into the same container.

### WEEE Treatment Methods

WEEE is pre-treated, which means that it is separated and dismantled, before being sent for further treatment. Pre-treatment is carried out at certified facilities, after which the waste is forwarded for final treatment or recycling. Components containing hazardous substances and waste are treated at approved treatment facilities. Once the hazardous substances are removed, a lot can be recycled. Plastic cases are incinerated in waste-to-energy plants and the metal is sent to smelting plants for recycling. Recovered copper, aluminium and iron are used as raw materials in new products.

Computers, mobile phones and other IT products contain small amounts of precious metals that are also recovered. Some printed circuit cards, for instance, contain gold or silver. In 2011, the portion of material recycling that includes WEEE, refrigeration units, batteries and bulky waste collected at municipal recycling centres stood at 312,630 tonnes or 33.2kg per person. Households and small businesses can drop off their bulky waste, WEEE and hazardous waste at manned municipal recycling stations.

### Certified Recycling

Recycling plants in Sweden that produce compost or digestate from separated bio-waste, including food waste from the food industry, can put quality labels on their products after being certified. Swedish Waste Management has developed this certification system in consultation with the agriculture and food industry, compost and digestate producers, soil producers, municipal authorities and research institutions. The Swedish organic label 'Krav' and the Swedish Seal of quality approve digestate that is based on source-separated food waste, which is certified in accordance with Swedish Waste Management's system.

The technical research institute of Sweden (SP) is the inspection body of this certification system. Around 90 per cent of all digestate used in agriculture today is certified. The system has not had the same impact on compost. One reason could be that compost is primarily used in



soil manufacturing and customers have not placed the same requirements on the product as the food industry has done on fertiliser for agricultural production.

### **Minimising Methane Emissions**

Swedish Waste Management is engaged in a voluntary initiative to minimise emissions from biogas by upgrading plants. Atmospheric emissions can arise at different stages of biological treatment through the anaerobic digestion of organic material and in biogas upgrading processes in treatment plants. Emissions from biogas plants are low but should be minimised. Around 40 biogas and upgrading plants in Sweden have signed up for this voluntary undertaking.

### **Residue**

The residue from incineration consists of slag from the furnace, 15–20 per cent of the weight of the treated waste, and flue gas treatment residues 3–5 per cent of the weight of treated waste. Some of the slag goes to landfill, while slag gravel may be used as substitute for natural gravel in road construction work and landfills. Flue gas treatment residues are either transported to landfills or used as a neutralisation agent when refilling mines.

### **Cost Of Waste Management In Sweden**

The ground rule in Sweden is that the polluter should pay. Waste collection fees in Sweden cover the total costs for the municipal waste management but deficits can be tax-funded. The municipal costs are charged as a separate waste collection fee while the producers' costs are fees included in the final price of their products. The local councils set the municipal waste collection fees and the producers decide on the amount of the product fee.

Administration, such as waste planning, customer service, invoicing and information are included in the costs. The fees also cover the service costs at the recycling centres for the collection and handling of bulky and hazardous household waste. The fee is often based on one fixed and one variable fee - one fee for waste collection and the other for waste treatment.

According to the self-cost principle in Sweden's local government act, the municipalities'



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revenue from fees may not exceed the costs of the municipal waste management. The average annual waste collection fee of a Swedish single-family house is SEK 2,000 (\$299). Apartment households pay an average of SEK 1,260 (\$188) and the average fee for second homes is SEK 1,130 (\$169) a year.

Many Swedish municipalities that introduced the voluntary collection of food waste use the fee as a means of control. Residents who choose a food waste subscription pay a lower fee than residents who choose to deposit mixed waste. To achieve a higher recycling rate for waste, several municipalities have introduced a fee based on weight, where households pay an additional per kg rate for waste collected on top of the basic fee.

In 2011, 29 municipalities implemented weight-based rates. Waste collection vehicles are equipped with a scale and equipment to identify each individual bin. The total annual cost for weight-based fees varies depending on the quantity of waste deposited for collection. The fee varies between SEK 1.30-3.50 (\$0.19-0.52) per kg for bins and bags, combined with different types of bin fees and the fixed basic fee. Some municipalities with food waste collection have lower weight charges for the food waste bin. The normal system, however, is to have the same weight charges for combustible waste and food waste.

The average annual per person cost of waste management in Sweden is SEK 670 (\$100), excluding the 25 per cent Value Added Tax (VAT). The annual average municipal cost for collecting waste in bins and bags is SEK 205 (\$31) per person. Treatment of the waste is not included in the cost. The annual basic fee of SEK 283 (\$42) per person covers the cost of recycling centres, treatment of hazardous waste from households, planning, information and administration.

Tax on landfilled waste was introduced in Sweden in 2000 as a way to reduce landfill. The tax was initially SEK 250 (\$37) per tonne, but has since been raised several times. Since 1 July 2006, the landfill tax has been set at SEK 435 (\$65) per tonne of waste. The landfill site operator is liable to pay the tax. Treatment fees can vary from one facility to another.

Industries are responsible for managing their own non-household waste. Some have their own landfill sites at their disposal or can recover energy from waste in their own incineration plants. The collection and handling of waste generated from construction, renovation, rebuilding



or demolition of buildings, or from more extensive ground installation projects do not fall under the responsibility of the municipality.

### **Turning Waste-To-Energy**

Waste has become an increasingly important fuel in the Swedish district heating systems. In 2011, Sweden used 2,235,720 tonnes or 235.8kg per person of household waste for energy recovery, which was 5.3 per cent more than 2010. Waste-to-energy is a method ideally suited for waste that cannot be recycled in any other way. It is an efficient and environmentally safe method for recovering energy from waste and provides both district heating and electricity in Sweden.

Sweden has 20 combined heat and power plants (CHPs), with an installed capacity of 465MW, that use municipal waste to produce electricity and heat. About 51.4 per cent of the total household waste in 2011 was used for energy recovery. This increase could be attributed to an 8 per cent rise in quantities of bulky waste to 1.6 million tonnes. A large portion of bulky waste goes to waste-to-energy. Sweden's power generation from waste went up by more than 11 per cent in 2011 to 2TWh/yr from 1.8TWh/yr in 2010. Total energy recovered from waste through incineration in 2011 stood at 15.5TWh/yr, up 7.6 per cent from 14.4TWh/yr a year earlier, and this included 13.5TWh/yr of heat, which was 7 per cent higher than 12.6TWh/yr produced in 2010.

Sweden now has more than 30 waste incineration plants, whose capacity is larger than the domestic supply of combustible waste. Sweden imported a total of 813,000 tonnes of waste in 2011, including household and industrial waste, which was 7.8 per cent more than the 748,000 tonnes imported in 2010. The Swedish waste-to-energy plants have a higher level of efficiency than their counterparts in Europe because they produce both district heating and electricity.

One tonne of waste in Sweden produces between 3-3.5 MW/hr of energy, of which 20-25 per cent is electricity and the rest is heat. Sweden is setting up several new combined heat and power (CHP) plants, which will use a combination of biomass and waste. The existing plants are using about 5.5mn t/yr of waste, which could increase to 6mn t/yr by 2017. Expansion of waste-to-energy generation will further push up the need for imported waste, which has



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increased in recent years. The need for imported waste could reach 1.6mn t/yr by 2015-16 due to higher demand from the heating and power generation plants.

### Energy from landfills

In 2011, approximately 270GWh of gas was produced from recovered landfill gas at 57 waste management plants in Sweden, of which 237GWh was used for energy. Energy recovery was 16GWh of electricity and 221GWh of heating and 32GWh of landfill gas was flared. Flaring does not produce energy but reduces methane emissions. In 2011, a total of 106 waste management plants in Sweden treated almost 9 million cubic meters of leachate, including polluted surface water from storage, separation and treatment areas. Swedish waste management plants are continuously reducing their reliance on landfills and only 68 of them are still landfilling waste.

### Swedish waste management and waste-to-energy companies:

- Swedish Waste Management <http://www.avfallsverige.se/in-english/>
- Renova <http://www.renova.se/in-english/>
- Hans Andersson Recycling <http://www.hansandersson.se/>
- Stena Metall <http://stenametall.se/en/>
- Flexus Balasystem <http://www.flexus.se/showartikel.asp?id=6>
- PUMPTEKNIK <http://www.pumpteknik.com/>
- AF <http://www.afconsult.com/en>
- Vattenfall Power Consultants <http://www.vattenfall.com/en/engineering-r-and-d-services.htm>
- Business Region Goteborg <http://www.businessregiongoteborg.com/huvudmeny/clusters/businessenvironment/ecoex/companydatabase/wasteandrecycling.4.209e6e8712be26ef9658000702.html>

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## WATER & WASTEWATER TREATMENT

Sweden has one of the most far-reaching effluent standards in the world for treated wastewater, far beyond the corresponding EU directive, and only about 30 per cent of the sludge is used in agriculture. The most intensive period for the construction of water and wastewater treatment plants in Sweden was the 1960s and 1970s. Investments in sewerage and wastewater treatment plants have decreased pollution in the lakes and water reservoirs. The load is at present down to the level at the beginning of the last century.

Sweden's 290 municipalities are responsible for the planning, construction and operation of water and wastewater treatment facilities. Sweden has more than 2,000 publicly owned water works, around 10 per cent of which are based on the withdrawal of surface water. These large water works serve 51 per cent of the population and some 7 per cent of the works source their water from artificial groundwater and serve around 23 per cent of the consumers. The groundwater-based plants - more than 1,700 - serve the remaining 26 per cent of more than 8 million customers, close to 90 per cent of the country's total population.

The water treatment plants in Sweden treat sanitary sewage, storm water from combined systems, drainage and infiltrated water. The plants treat almost double the volume of drinking water produced, and produce more than 230,000 tonnes of sludge annually. This sludge contains over 6,000 tonnes of phosphorus, which could be used as fertilisers for up to 8 per cent of the total arable land in the country.

More than 8 million people living in urban areas of Sweden are connected to sewage plants. Biological, chemical and nitrogen removal treatment plants serve more than 36 per cent of the connected population. Biological and chemical treatment plants serve 58 per cent and biological only or chemical only plants serve the remaining population. Two thirds of utilities cover their costs by means of fees. Around 99 per cent of the costs of capital and running are retrieved by means of tariffs.

The effluent from municipal wastewater treatment plants in Sweden is subject to the licensing rules under the Environmental Code, a framework covering most of the legislation relevant to the environment. Other major legislation within the field is the Health Act, the Public Water and Wastewater Plant Act, and the Food Act. Maintaining a good and healthy quality of drinking water in Sweden is the responsibility of the Ministry of Agriculture, with the National Food Administration as the central supervising agency. On a local level the municipal committee for environment and health supervises water and wastewater operations.



The Ministry of Environment is responsible for water protection. The Environmental Protection Agency (EPA) is the supervisory body on a central level, the county administration on a regional level, and the municipal committee for environment and health on the local level. Permits for the discharge of treated sewage are granted by the Regional Environmental Courts for the largest plants. A Supreme Environmental Court deals with appeals. The County Administrative Board issues permits for most plants, and for the smallest plants the municipal environment and health committee may give its approval.

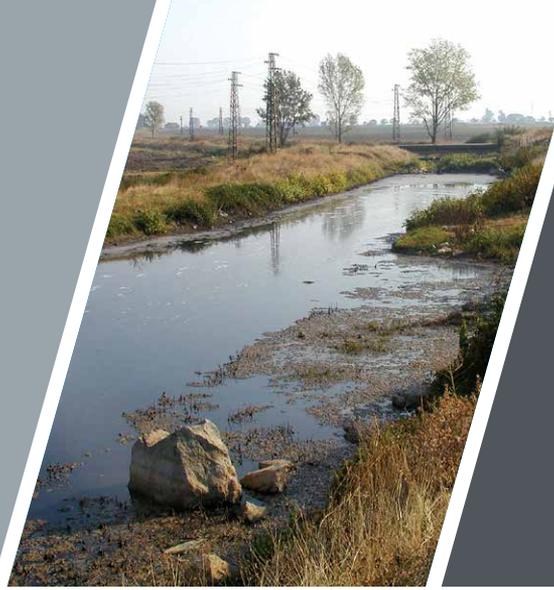
### **Proactive Management Of Water Resources**

Sweden is rich in water and lakes account for 9 per cent of the country's total area of 450,295 square kilometres. There are around 100,000 lakes in Sweden and 90 per cent of them have an area less than 1 square kilometre. Average annual rainfall varies from 600 millimetres in the southeast to over 1,500 millimetres in the mountains in the northwest of the country. The average runoff in all rivers of Sweden amounts to nearly 200 cubic kilometer, and only 0.5 per cent of the theoretically available resource is extracted for municipal use.

Other consumers of water in Sweden, such as industry and farming, use around three times more water than the municipalities. Water supply is not a major problem in Sweden, but the quality of raw water is not uniform and requires various levels of treatment. Average production of water in Sweden stands at around 330 litres per person a day. Of this, a little less than 200 litres is used in households, 130 litres is used in production, industries and for use in official premises and also includes leakage on the distribution network. The leakage represents on average 20 per cent of the total water produced.

The average 200 litres a day of water consumption in Swedish households comprises 10 litres for drinking and food, 40 for flushing the WC, 40 for dishwashing, 30 for laundry, 70 for personal hygiene and 10 litres per person a day for other uses. Drinking water in Sweden is classified as food and the water works are run like food production units. It is possible to produce good quality drinking water from surface water as well as from groundwater. Groundwater has several advantages compared to surface water due to lower temperature and smaller contents of unwanted organic substances and bacteria.

Groundwater resources in Sweden are not enough to supply the whole country. Artificial infiltration is used to gain advantages of groundwater and minimise the use of chemicals in



## WATER & WASTEWATER TREATMENT

water production. In most parts of Sweden, there is no incentive for saving water from a water resources perspective and reasons for saving water may instead be expressed as minimising the flows to the wastewater treatment plants, optimising their efficiency and minimising the costs for pumping and chemicals.

### **Innovative Water & Wastewater Treatment Technologies**

Sweden's early investments in water and wastewater treatment technologies have led to the development of a wide range of innovative solutions of all types and sizes that are being implemented in many countries around the world. The Stockholm International Water Institute (SIWI) conducts extensive research on regional and global water issues and brings together leading minds from around the world to discuss and overcome the challenges of today and tomorrow.

Swedish companies have been at the forefront of global innovation for securing sustainable water supplies for today and tomorrow, and there have been several inventions that have developed practical solutions for treating wastewater, sewage, brackish water, improving the quality of groundwater, and making use of rainwater that is often never utilised and remains stagnated in the form of ponds and contaminated bodies of water causing diseases that could be prevented through the application of technology.

Global research has revealed that today 2.6 billion people around the world lack improved sanitation, about 800 million lack safe drinking water, one billion go to bed hungry, 2 billion people are undernourished and 60 per cent of the earth's ecosystem services are deteriorating. All these challenges are directly linked with water security which plays a crucial role in increasing sustainable investments in agriculture, creating enabling conditions that include incentive mechanisms, policy cohesion and institutional design, as well as strengthening and understanding the link between water, energy and food.

Sweden may not be able to solve the whole world's water and wastewater management problems, but it can certainly play a significant role in overcoming many common challenges in developing countries by providing technologies to purify water through the use of solar power, chemical-free treatment and innovative water recycling solutions that have created hope and new ways of overcoming the challenge of water scarcity. Many Swedish companies are at the forefront of global innovation and research for water security.



## Leading Swedish water and wastewater management companies

- OneWell AB <http://onewellsweden.com/>
- Solvatten <http://www.solvatten.se>
- Wallenius Water <http://www.walleniuswater.se>
- SolarWave <http://solarwave.se>
- Urban Water Management <http://www.smtc.se/foretagdetaljer?p=412>
- VASYD <http://www.vasyd.se/en/Pages/default.aspx>
- Watreco <http://www.watreco.com>
- Vattenhuset <http://www.vattenhuset.se/swe/startside>
- ITT Water & Wastewater <http://www.itt.se>
- Xzero AB <http://www.xzero.se>
- Sustainable Business Hub <http://www.sbhub.se/index.php?cat=start>
- Rosqvist Resurs <http://rosqvist-resurs.se/english1.html>
- Biosling <http://biosling.se/en/products/the-sling-pump/>
- Lackeby Water Group <http://www.lackebywater.se/index3.html>
- Cactus <http://www.cactusuniview.se/en/>
- VA Teknik <http://www.vateknik.se/index.asp>
- Gryaab <http://www.gryaab.se/default.asp>
- Pumpteknik <http://www.pumpteknik.com/>
- Hifab <http://www.hifab.se/Default.aspx?epslanguage=SV>
- Tyréns <http://www.tyrens.se/en/Services/EN-Vatten/>
- ÅF <http://www.afconsult.com/en/Sectors/Industry/Water-and-Wastewater-Treatment/>
- WSP [http://www.wspgroup.com/en/Sectors/Sectors-Container/water\\_management/](http://www.wspgroup.com/en/Sectors/Sectors-Container/water_management/)
- Business Region Goteborg <http://www.businessregiongoteborg.com/huvudmeny/clusters/businessenvironment/ecoex/companydatabase/water.4.209e6e8712be26ef9658000799.html>
- Ekobalans <http://www.ekobalans.se/en/tjanster/biogasproducent.html?id=18>

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## WIND ENERGY: Making use of an abundant resource

Sweden's wind power production went up by 18 per cent in 2012 to 7.2 TWh from 6.1 TWh in 2011. Electricity production from wind power has increased significantly over the last decade and has contributed to both pushing down the price of electricity and reducing greenhouse gas emissions from coal plants in neighbouring countries (see table). Industry association Swedish Wind Energy estimates that wind power could produce 11 TWh by 2014, and with the right conditions Sweden could quadruple wind power production to 30 TWh in 2020, representing about 20pc of total electricity consumption in the country.

Wind power is increasing competition in the Swedish electricity market. It creates supply and provides the opportunity for individuals to own their own electricity. Sweden is, therefore, developing wind farms at a rapid pace, making use of good wind conditions in the south and north of the country. Wind power is viewed as a viable and preferred alternative for nuclear power, as several of Sweden's nuclear power plants are due to retire in the coming years. It also plays a pivotal role in the development of renewable energy sources that could ensure a cleaner environment and long-term sustainable development.

Sweden's installed wind power capacity increased by a record 1.08GW during 2012 and reached 4GW by the end of the year, with the installation of 457 new wind turbines. In 2012, Sweden installed 846MW of new wind power capacity compared with 755MW in 2011. Around 1.33GW of new capacity is on order for construction during 2013. Aside from the projects under construction and already ordered wind turbines, there are now projects with combined capacity of 3.8GW with all permits in place. Another 9GW, now going through the licensing process, could be built by 2016.

The wind power lobby in Sweden is pushing for speedier project approvals. The wind lobby argues that Sweden has 26 times more land than Germany, but Germany has more wind power than Sweden and the availability of land gives Sweden an advantage to push wind power as a major source of renewable energy. Advancements in technology have made wind power competitive in comparison with other sources of electricity. Since the 1980s, the price of electricity produced from wind has fallen by 80 per cent, while wind turbines have become larger and more efficient.

At present, the cost of electricity produced from wind in Sweden ranges between SEK 0.60-0.70kWh (\$0.0900-0.1050kWh) with a modern wind turbine, depending on wind conditions, and



costs are expected to continue to decline with expansion in wind power capacity. The average installation cost of wind power in Sweden now stands at around SEK 12 million (\$1.83 million) per MW and operations costs range between SEK 100-140 (\$16-21) per MWh, which includes insurance and the cost of changing the gear box or other equipment of the wind turbines over a 20-year lifecycle. Turbines make up for 85 per cent of the total cost and the remaining 15 per cent is the cost of connecting the wind farms with the national power grid, building the foundations and other infrastructure.

### **Small-scale wind power**

Small-scale wind power projects play an important role in meeting the electricity needs of small communities and industries in many parts Sweden. There are several Swedish wind power companies that have developed small-scale solutions that could be implemented at a fraction of the cost of large-scale wind power projects. These solutions could play a pivotal role in meeting the electricity requirements in developing countries, where a large part of the population is not connected to the national electricity grids.

Chamber Trade Sweden (CTS) has been approached by local governments and industries in many developing countries who are seeking medium to small-scale wind power solutions to meet their electricity needs, which are not being met due to chronic power shortages and outages that have a negative impact on productivity. There have been several inquiries for projects ranging from 20-200kW and up to 1MW and more, and several Swedish companies are being connected with prospective buyers and developers of small-scale and medium-sized wind power projects in several developing countries.



## WIND ENERGY: Making use of an abundant resource

### Wind power companies in Sweden

- Pitchwind <http://www.pitchwind.com/index.html>
- SKF <http://www.skf.com/portal/skf/home/products?contentId=000392&lang=en>
- Diab [http://www.diabgroup.com/europe/opening/e\\_home.html](http://www.diabgroup.com/europe/opening/e_home.html)
- Mattssonföretagen <http://www.mattsson.se/en/home.html>
- Business Region Goteborg <http://www.businessregiongoteborg.com/huvudmeny/clusters/businessenvironment/ecoex/companydatabase/wasteandrecycling.4.209e6e8712be26ef9658000702.html>
- Windon <http://www.windon.se/en/>
- O2 <http://www.o2.se/in-english/>
- Svensk Vind Energi <http://www.vindkraftsbranschen.se>
- Arise Windpower <http://arisewindpower.se/en>
- Eolus <http://www.eolusvind.com/English/tabid/4619/Default.aspx>
- Vindin <http://vindin.se/index.php/se/>

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### Sweden power production 2012/2012

Year	Production (TWh)
2012	7.2
2011	6.1
2010	3.5
2009	2.5
2008	2.0
2007	1.4
2006	1.0

Source: Swedish Wind Energy



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