This Is Bioenergy!

FACT SHEET: 7/98 • Bioenergy from domestic and industrial waste

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Swedish Bioenergy
ociation, SVEBIO, was
ned in 1980. Its members
sist of private persons,
panies, authorities and
anisations. The Association
ks for an increased use of
energy in an environmentally
siderate and optimal manner.

LIMFJ ENERGI AB

A grab lifts the waste from the bunker and dumps it into the incinerator.

Waste full of energy

■■ Forget the consumer society! Today we know that it cannot continue. We must make use of the Earth's resources sparingly and carefully so as to create as little waste as possible. The residual products that society nonetheless produces can be used either by recycling or by using the material to produce energy. In that role, waste is a resource. Waste is an energy raw product that is playing an increasingly important role in the Swedish energy system.

A certain amount of energy is extracted from Swedish landfills in the form of landfill gas. Digestion is another way of extracting energy from waste, and is used also in sewage treatment plants.

Nonetheless, incineration of waste is the most efficient way of extracting energy from waste. Incineration techniques have become more effective and today emissions of hazardous substances are a fraction of what they were in the mid-1980s. Since 1980 the amounts of waste arriving at Swedish incineration plants have increased two-fold, whereas energy extraction has increased four-fold.

Waste used for energy extraction consists largely of biofuel. The largest part comes from households.

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Ways to do it

Combustion, gas extraction from landfills or in digestion chambers and thermal gasification are the four methods that can be used to extract energy from waste.

● Combustion

The waste is dumped into a large bunker and fed into the incinerator by means of a grab. There are two types of incinerators - grates and fluidised beds.

Combustion on grates is the most common. Here the waste is fed forwards onto an oscillating grate. In this way the waste becomes mixed and distributed more evenly, thereby enabling the combustion to be as uniform as possible. By supplying large amounts of air and with a high temperature in the furnace, the combustion will be effective.

Combustion in a fluidised bed incinerator involves air being blown through a perforated plate on which the waste is lying together with sand, ashes and sometimes lime. The fuel makes up only a small part of the contents of the bed. When air is blown into the bed it starts to behave in the same way as fluid, thus its name. Burning waste in a fluidised bed incinerator places higher requirements on fuel quality. The fuel has to be of more similar size and composition than fuel used in a grate incinerator.

The hot exhaust gases from the incineration are used to heat pipes containing water that line the boiler. A heat exchanger transfers the heat from the water in the pipes to the district heating system. In co-generation plants, where both electricity and heat are produced, the water in the pipes is first heated to provide steam which powers a turbine. When the steam has passed through the turbine, heat is transferred from the steam to the district heating water. The slag remaining after the incineration can either be placed in a landfill or used as aggregate in building foundations or road construction. The fly ashes contain toxic substances and are separated in a filter and treated as environmentally hazardous material.

A resource to utilise

■■ Waste is an important source of energy. It supplies Swedish society with energy corresponding to more than 5 terawatt-hours (TWh) annually. In fact, waste is responsible for 10 per cent of the Swedish district heating. SVEBIO estimates that the importance of waste for supplies of energy will increase. In 20 years time 15 TWh of energy can be produced from waste, partly in waste incineration plants and partly in digestion chambers and as landfill gas.

Extracting energy from waste is of great importance for the handling of waste. This is a method of reducing the huge amounts of Swedish waste that must be placed in landfills - 3.5 million tonnes of household waste and 4.2 million tonnes of industrial waste.

INCINERATION BEST

The amount of waste sent for incineration has doubled since 1980. During the same period, energy production has increased four-fold. As a result of sorting, the incinerated waste has become more energy-rich at the same time as incineration technology has been developed.

Incineration of waste is the most hygienic, environmentally considerate and energy effective method of handling the vast amounts of waste produced by modern society. It is also the most effective way of reducing these amounts - slag and ashes remaining after incineration amount to only one-fourth of the weight of the original material.

By far the largest amount of the combustible waste originates in the home. More than 1.3 million tonnes of household waste were incinerated in 1996 in the 21 municipal district heating plants for waste incineration in Sweden. Of the total amount of industrial waste, only 13 per cent was incinerated, or 560 000 tonnes. Here there is scope for increased utilisation .

Incineration of waste requires advanced equipment. The fuel has different characteristics both as regards content and size, which places specific demands on the incineration equipment. Since the fuel has a mixed composition, the incineration leads to the formation of several more or less undesirable substances and efficient flue gas cleaning is necessary. This requires major investments. Waste incineration must be done on a large-scale in order to become rational.

At the same time, it is in the large urban areas that the largest amounts of waste are produced and where the energy requirement is greatest. Consequently, it is in large urban centres with a comprehensive district heating network that incineration is most suitable. It is important that the load on the network during the summer is sufficiently large to be able to continue with heat production.

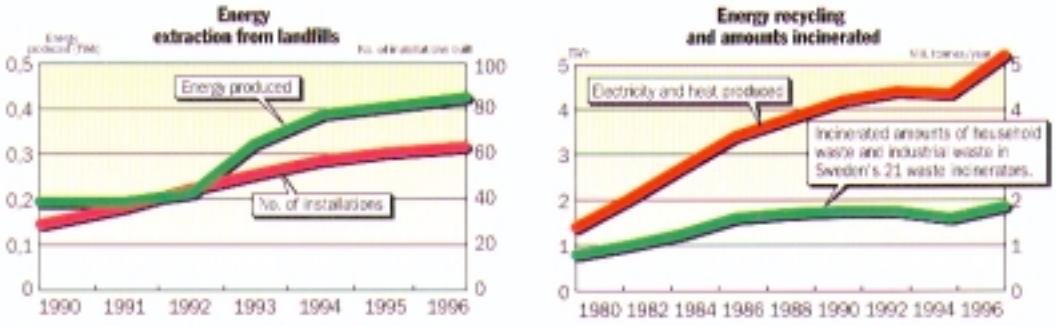
Locally in Sweden up to 40 per cent of the district heating is provided by incineration of waste.

LANDFILLS AN EMERGENCY SOLUTION

Waste from 145 municipalities is delivered to the Swedish incineration plants. In places where the transport distances are long and where there is insufficient capacity for a large incinerator and boiler, the waste must be dealt with in another way. After sorting and recycling, the remainder is placed in a landfill. This also occurs in places that already have an incinerator that cannot cope with all types of waste, e.g. certain types of domestic waste, park and garden waste, construction and demolition waste, different

KJELL-ARNE LARSSON

Demolition waste is chipped and incinerated instead of being deposited in a landfill. This is a good way of making use of waste.



Energy extraction from waste is becoming increasingly effective, particularly as regards incineration.

types of industrial waste, sludge from municipal and industrial sewage processing plants, waste from extraction of mineral products, special category waste and slag from waste incineration, etc. The hazardous substances that are separated in the flue gas filters are classified as hazardous waste and are processed in special installations.

Society strives to minimise landfilling and this is emphasised by the introduction of a tax on landfilled waste. As much as possible must be processed in other ways - by recycling, reusing and by incineration.

The amount that nonetheless must be landfilled can still be used for energy purposes. Even though less energy can be extracted from landfilled waste than from incineration of it, 56 landfills produced more than 0.4 TWh of biogas in 1996, which was mainly used to produce heat.

Despite gas being extracted from the landfilled waste there is still a risk that the methane evolved leaks into the atmosphere. The greenhouse gas methane speeds up the warming of the Earth. Since methane is 20-25 times stronger than carbon dioxide it is important that biologically decomposable waste is incinerated or correctly landfilled at a site with methane extraction.

Incineration of waste is clean

■■ The waste branch has long been labelled as being environmentally destructive. Nonetheless, since the height of the dioxin debate in the mid-1980s there have been dramatic changes. The authorities have imposed strict demands on emissions from waste incineration. Emissions from incineration plants have decreased by more than 90 per cent, with the exception of sulphur- and nitrogen oxides. Waste incineration can no longer be linked with unhealthy and environmentally hazardous emissions.

In 1996 the amount of waste incinerated was 21 per cent more than the amount in 1985. Despite this increase in the amount of incinerated waste the emissions of heavy metals disappeared almost entirely. Today it is only 1-2 per cent in comparison with 1985.

By means of waste sorting the material being incinerated has become cleaner. Collection of batteries, for example, has been of great importance for minimising emissions of mercury, cadmium and lead. At the same time the technology for cleaning flue gases has been improved. This not only concerns the toxic heavy metals and the highly toxic organochlorine compounds called dioxins. Emissions of particles as well as corrosive and acidic hydrogen chloride are today less than one-tenth of emissions in 1985. Emissions of acidic sulphur oxides and nitrogen oxides have been reduced by more than half.

In order to reduce further the emissions of nitrogen oxides there has been a development of advanced cleaning technology for incineration of waste. By injecting ammonia or a solution of urea into the hearth it is possible to reduce the nitrogen oxides by more than two-thirds. In a second step a catalyzer can remove an additional 20-25 per cent. Full-scale experiments at the Malmö incineration plant have demonstrated that it is fully possible to reduce the nitrogen oxides by 85 per cent.

Sweden has been in the forefront as regards cleaning emissions from incineration of waste, but today other countries have caught up. New EU directives are being elaborated and the demands in the new EU regulations will be even stricter than the present Swedish ones.

EMISSIONS TO THE ATMOSPHERE FROM WASTE INCINERATION IN SWEDEN

Substance	1985	1991	1996	Change 1985-96
Particles	420 tonnes	45 tonnes	33 tonnes	-92 %
Hydrogen chloride	8 400 tonnes	410 tonnes	412 tonnes	-95 %
Sulphur oxides	3 400 tonnes	700 tonnes	1 121 tonnes	-67 %
Nitrogen oxides	3 400 tonnes	3 200 tonnes	1 463 tonnes	-57 %
Mercury	3 300 kg	170 kg	77 kg	-98 %
Cadmium	400 kg	35 kg	8 kg	-98 %
Lead	25 000 kg	720 kg	214 kg	-99 %
Dioxins	90 gram	8 gram	2 gram	-98 %

● Landfill gas

Formerly, landfills were called tips or rubbish dumps. A large part of the waste arriving at a landfill will be sorted. Some of it will be composted, whereas some will be stored for later recycling. The total amount destined for landfills in Sweden is about six million tonnes per year, of which about one million tonnes are composted or recycled. Thus, five million tonnes of waste are dumped deposited in landfills annually.

When treated in a digestion chamber organic waste decomposes in the same way as waste, but much slower.

Methane is formed in the landfill. Rainwater seeping through the landfill leaches out substances present in the material. Leach water is an environmental problem and normally it is collected and purified.

In old landfills, not originally planned for gas extraction, the gas is extracted by suction through bore-holes drilled into the landfill. In new landfills, horizontal pipes, through which the gas is extracted, are laid out at the same time as the waste is deposited. Deposition in biocells should be used for waste that contains large amounts of organic material, e.g., domestic waste. Biocells are enclosed pockets where each cell functions as a digestion chamber. Since methane forms after only a few weeks the gas can be extracted at an early stage. Deposits in biocells are easier to control than conventional landfills. It is easier to prevent methane leaking out to the atmosphere and to collect the leach water. After about ten years the biocell can be emptied and the material used as a soil conditioner, or as a mulch, etc.

● Digester gas

Organic material can be digested to yield methane that can be used for energy purposes. The crude material may be pure organic waste fractions, sludge, waste from the food industry, manure or crops. The digestion takes place in a chamber where the waste is decomposed in an oxygen-free environment. Heat and water are provided enabling organisms in the anaerobic environment to efficiently process the waste. After two or

More incineration and stricter demands

■■ In the future it is probable that more waste will be incinerated and less dumped in landfills. Much more of the industrial waste can be used as an energy raw product in comparison with the amount incinerated today. The Swedish Environmental Protection Agency estimates that waste incineration will increase by 30 per cent from 1994 to 2000.
Both Swedish regulations for handling waste as well as EU directives suggest that there will be more incineration. The energy obtained in material such as fuel can be compared with the energy consumed in retrieving and reprocessing it. The decision-makers consider that waste is a raw product that replaces other fuels.
In Sweden a landfill tax is being prepared, together with a ban on landfilling combustible waste. The Swedish packaging regulations place a number of goals for material recycling. Producers are required to recycle a certain percentage of different types of packages. The legislation allows some material to be reused by incineration. This is in harmony with the EU packaging directive that classifies incineration as a complement to material recycling. Naturally, not everything can be incinerated. There is no point is sending glass and metal for incineration. However, according to the EU up to 40 per cent of plastic packaging, for example, can be reused through incineration.
At the same time the EU places strict demands on flue gas cleaning from waste incineration. Hitherto, Sweden has had the most demanding environmental regulations in the world, but new EU regulations being prepared today, probably coming into force in a few years time, imply further tightening up of the requirements.
In Sweden, several organisations are co-operating in the elaboration of new guidelines for quality control and environmental guidance for waste incineration. Systems for quality control and environmental guidance are a means of creating order in the activities - a kind of guarantee for full control. At present 13 plants for incineration of waste in Sweden are preparing an environmental control system in accordance with the international ISO standard or EU's EMAS standard.

CO-INCINERATION

In pace with increasingly clean fuel fractions being obtained, possibilities are being tested to co-incinerate waste with solid fuels such as peat or wood chips in boilers with good flue gas cleaning. In the long-term perspective this may be a solution to the problem in places located far from waste incineration plants. Environmental demands on co-incineration will probably be influenced by EU's regulations relating to waste. It is anticipated that the demands will be largely similar to those for waste incineration.
Experiments with co-incineration are ongoing in Norrköping and will be evaluated in 1998.

three weeks the waste has decomposed and biogas has become formed. The biogas consists largely of methane and carbon dioxide. The digestion residue can be used as manure in agriculture provided that it fulfils strict requirements concerning contents of heavy metals and other hazardous substances.
So far, biogas has been a residual product from digestion of municipal waste, from digestion chambers for waste from the food industry, or from industrial wastewater. In cases where it is not burnt-off it is used to heat premises and for process energy. It can also be used as a propellant fuel or to produce electricity.

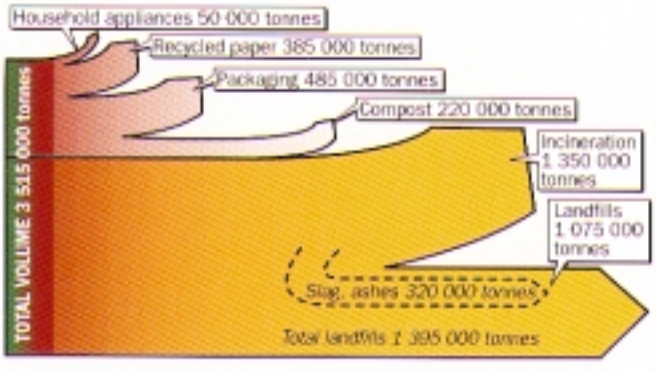
● Thermal gasification

Thermal gasification, or pyrolysis, is an alternative to incineration of waste. The technology is based on the fuel being heated up in an air-deficient environment. The fuel does not burn but disintegrates into gas and fluid slag. This technique is not being used at present in Sweden.

Biofuel in the trash can

■■ The average Swede creates 300 kg of household waste per year. What we usually throw into the dustbin during our daily life at home can usually be used in one way or another. About one-third of the household waste can be sorted out and reused or processed in other ways, e.g., waste paper, glass, household appliances and electronic scrap. Some of the organic material is composted. Of the two-thirds that remain about half is incinerated in municipal incineration plants. Altogether, 1.3 million tonnes of waste can produce 4.6 TWh.
In Sweden, heat is in great demand as a result of the climate. Therefore, it is important that we utilise the resources available to produce energy. Household waste is important in this context. The total amount of waste created by 25 people is sufficient to provide heating for an entire villa.
Household waste may be regarded as a biofuel. It consists to 90 per cent of organic material well-suited for incineration - both from energy and environmental viewpoints. In comparison with being dumped in a landfill, the net emissions of greenhouse gases are negligible.

Recovery and processing of domestic waste, 1996



More than one-third of all household waste is incinerated and contributes to the Swedish energy supply. About one-third is recycled and composted, the rest is placed in landfills.

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