Environmental protection and environmental and energy technology

Sustainable development throughout society should be the objective of Sweden’s environmental work both inside and outside its borders. This requires major behavioral changes at all levels and in all areas of society and a new environmental policy.

Another important precondition for success is that technology provides us with new ways to counteract threats to our health and environment. Environmental technology has emerged as a new economic sector in Sweden. Today it includes air pollution control, water and wastewater treatment, waste management and recycling, as well as renewable energy and energy efficiency improvement. An essential part of this sector is renewable energy technology. The supply of renewable energy has more than doubled since the oil crisis of the 1970’s. Bioenergy and hydroelectric power account for more than half the increase, but the country has also invested in wind, solar and geothermal energy.
Sustainable development – the objective for our common future

At the 1992 United Nations Conference on Environment and Development in Rio de Janeiro, world political leaders pledged to work toward sustainable development. This means that all development should meet economic, social and ecological objectives – both for the current generation and future generations. The basic living conditions of the world’s poor must be assigned top priority. These principles were further developed at the 2002 World Summit on Sustainable Development in Johannesburg.

In the environment field, this means for instance that:

- Natural resources, particularly clean water and energy sources, have to be allocated more fairly and used much more efficiently.
- Materials are to be reused or recycled. Technical development is to be directed toward low-resource products and methods.
- Emissions of pollutants must not be larger than people or the environment can tolerate. Harmful substances that are alien to nature will eventually have no place in the environment.
- Biological diversity has to be safeguarded and valuable cultural environments must be preserved.

The European Union (EU), the Organization for Economic Cooperation and Development (OECD) and the United Nations Economic Commission for Europe (UNECE) have decided that national economic development may not result in damage to the environment.

New lifestyle essential

Sustainable development requires behavioral changes at all levels, in all areas of society – but also a new environmental policy. It was not until after World War II that Sweden began to look more closely at the effects of industrial emissions, which were initially viewed as a local problem only. In the 1960s and 1970s, when thousands of lakes and wide stretches of forest had already been damaged, the Swedes became acutely aware that pollutants do not respect national boundaries.

Measures to curb emissions from industries and incineration plants in Sweden were largely successful. Earlier, environmental improvement focused mainly on production processes. Often, environmental impacts have moved from production to the use, consumption and disposal stages. Lifestyles involving greater comfort and a constant growth in consumption are causing a steady increase in chemicals, heavy metals and other harmful substances in our products.

Today, emissions of carbon dioxide, noise and congestion are growing more rapidly than the economy in Sweden. More traffic and larger cars are devouring some of the gains from better exhaust emission control, cleaner fuels and noise reduction. The same applies to growing dependence on energy as a result of greater automation and consumption.

Development in the right direction

Before Sweden can achieve its 16 official environmental quality objectives (see below), it must overcome a mixed record of developments affecting environmental conditions. On the plus side is that waterways, land and forests are healthier and corrosion of metals and buildings has been more than halved. The early Swedish ban on substances that deplete the protective stratospheric ozone layer has proved a success and has been adopted internationally.

Sweden is committed to reducing its greenhouse gas emissions by 4% from 1990 to 2012. By 2004 they were 3.5% below the 1990 figures, or 6.2 tons per capita. Looking further ahead, however, emissions must be reduced much more. In 2006 the government pledged to end Sweden’s dependence on oil by 2020.

Some 3,700 areas with valuable natural environments receive special protection. Wetlands are thriving and nearly 10% of cropland is organically cultivated.

Traffic and energy the toughest challenge

Around 75% of greenhouse gas emissions come from the energy and transportation sectors. Initiatives to encourage the use of alternative energy sources and to save energy in buildings have admittedly reduced the need for fossil fuels. But in transportation, especially road traffic, fossil fuel consumption has increased. Higher fuel prices now seem to be expediting the introduction of engines that consume less or no fossil gasoline and fossil diesel oil.

Air quality is also cause for concern. Particulate matter from combustion causes lung cancer and respiratory diseases and can aggravate heart conditions in sensitive individuals. Among airborne pollutants that are hazardous to health are nitrogen oxides. Sweden is failing to achieve its reduction target, partly because emissions from elsewhere in Europe arrive here with the winds. However, Sweden is hopeful that nitrogen oxide levels will decline by 2010 as a consequence of international measures.

Nitrogen and phosphorus discharges into water from households, industrial plants and agriculture are still causing eutrophication, sometimes in the form of large-scale algal blooms, oxygen deficiency and mass flora and fauna death in lakes, rivers and coastal waters. Fishing and recreational activities in and around the water are severely affected.

Although sulfur dioxide emissions have sharply declined, acidification is still high in the southern parts of Sweden, now due to ammonia and nitrogen oxides.

The Baltic Sea receives waterborne pollutants from twelve countries and is affected by increasing oil discharges from both vessels and fixed sources. It is also affected by new environmental toxins, including hormone-disrupting brominated flame retardants. International cooperation is needed to save this largely inland sea, in which extensive areas of deep water have become lifeless due to eutrophication.
High-level exploitation of forests, waters and other natural resources is damaging ecosystems.

Sweden has established 16 overarching environmental objectives that are framed as general targets:

1. Reduced climate impact
2. Clean air
3. Natural acidification only
4. A non-toxic environment
5. A protective ozone layer
6. A safe radiation environment
7. Zero eutrophication
8. Flourishing lakes and streams
9. Good-quality groundwater
10. A balanced marine environment, flourishing coastal areas and archipelagos
11. Thriving wetlands
12. Sustainable forests
13. A varied agricultural landscape
14. A magnificent mountain landscape
15. A good built environment
16. A rich diversity of plant and animal life

Central, regional and local governments in Sweden have drawn up more detailed objectives and strategies within their own fields of activity, to be achieved by 2020–2025.

Legal framework for a good environment

A new Swedish Environmental Code went into effect in 1999. Sustainable development and other overall principles also gained legal authority in the Code. These include the precautionary principle, the polluter pays principle, the product choice principle and principles related to resource management, ecocycles and suitable locations for activities. Those engaged in major activities that may harm the environment must present an environment impact assessment when applying for a permit. If a permit is granted, the regulatory authority in charge will state certain terms and conditions.

The Environmental Code allows the protection of endangered species and types of areas. Examples are biotope protection, bird sanctuaries, shoreline protection, national parks and nature reserves.

The Code expands the concept of environmental crime. Environmental sanction charges can be levied directly by a government agency in charge of oversight, where it notes an infringement. Fines or imprisonment agency in charge of oversight, where charges can be levied directly by a government in charge of oversight, where

Among Sweden’s environmentally related taxes or charges are:

- Sulfur and carbon dioxide tax.
- Energy tax – paid for use of fossil fuels and electricity. A system of "green energy certificates" compels power producers to offer a certain share of renewable energy.
- Nitrogen oxide charge, including power plants. The charge is refunded to payers with the lowest emissions of nitrogen oxide per energy unit generated.
- Environmental classification of cars and fuels. Models and fuels with the lowest emissions are rewarded with lower taxes.
- Farmers pay tax on pesticides and on cadmium in fertilizers.
- A charge on environmentally hazardous batteries, equivalent to the cost of final disposal.
- A landfill tax applies, to be followed by a waste incineration tax. In addition, local authorities can impose differentiated charges.
- Consumers pay deposits or charges for collection and recycling of electric and electronic equipment, packaging, paper and tires.
- Civil aviation is subject to charges that vary depending on aircraft emissions and noise. In addition, a tax is imposed on airline tickets.
- A general harbor fee covers correct treatment of shipping waste, whether ships leave their waste or not. This is to discourage waste pollution at sea. Another fee is differentiated according to the sulfur content of the vessel’s fuel.

Among grants intended to encourage more environmentally friendly operations or to repair environmental damages are subsidies for greenhouse gas reduction investments, "liming" of acid forests and lakes, organic cultivation, nature conservation in rural areas, combating radon in water and clean-ups of oil discharges. Other forms of assistance include investments in sustainable development, district heating, reduced electricity use and environmentally friendly technology.

Research and monitoring programs are aimed at delivering necessary information on the state of the environment and on the efficiency of policies and measures employed and to suggest new objectives or methods.

Globalization

The most serious challenges to the environment today are due to greater consumption, with increasing worldwide trade and transportation. These challenges can be dealt with only through international cooperation.

Sweden organized the first global environmental conference in Stockholm in 1972 and is still working to promote environmental progress in the global arena. This includes enhancing international environmental treaties. Among the most important to Sweden are the efforts of the Helsinki Commission and the Oslo and Paris Conventions to protect our neighboring seas. The Stockholm Convention, which aims at phasing out the production and use of some of the most hazardous chemicals, was largely a Swedish initiative.

Sweden is also active in the UN Commission on Sustainable Development, which oversees the implementation of worldwide environmental action plans decided in Rio in 1992 and in Johannesburg in 2002.

Sweden’s EU membership since 1995 has also led to major changes in its environmental policy. On the one hand, Sweden has been forced to give up some stricter standards. On the other hand, the EU can better influence countries whose emissions may rain down on Sweden. The EU has also greater clout than its individual member countries in negotiating global environmental conventions. Sweden must be proactive in bringing about strategic energy cooperation among the EU, China and India in supporting their efforts to limit their emissions of greenhouse gases.

In recent years, direct Swedish government appropriations to environmental protection have totaled around 0.5% of the national budget. In 2006, such appropriations are SEK 4.6 billion (bn). However, in 2007 and 2008, they will total about SEK 4.6 bn due to certain reallocations to another expenditure area in the budget.

In addition, the government finances environment protection measures by means of general subsidies and charges. Together with environmental protection costs in industry, total annual expenditures for the environment are around SEK 30–40 bn.

Environmental technology – an expansive sector

Since 1999, the environmental technology export project within the Swedish Trade Council in cooperation with Swedish companies has led to the emergence of a new industrial sector. Today this is defined as the Swedish Environmental Technology Network, including the fields of water and wastewater treatment, waste management.
and recycling, renewable energy and energy efficiency improvement as well as air pollution control. The Network today includes nearly 700 companies.

Because environmental technology today is a concept that brings together a large number of specialties previously allocated among several sectors, establishment of the network has also signified a form of market adaptation. Companies that only have a portion of their overall production or services in environmental technology have now gained a new arena to work in.

Environmental technology enterprises are often active in more than one of the specified fields of operations. Forty percent of environmental technology companies specialize in water and wastewater treatment, 36% in waste management and recycling and 25% in air pollution control. Forty-eight percent of companies fall within the field of renewable energy and energy efficiency improvement.

Today the Swedish Environmental Technology Network includes nearly 700 Swedish companies that:

- have business operations/manufacturing and employees in Sweden,
- work wholly or partly with environmental technology related to water and wastewater treatment, waste management and recycling, air pollution control, renewable energy (such as bioenergy, wind power and solar energy) and energy efficiency improvement, and
- export goods and services.

**Swedish success factors**

Swedish manufacturers and suppliers of environmental technology equipment share the Swedish engineering industry’s good reputation for high quality, operating reliability and delivery assurance. Swedish companies also have advanced expertise in operation and maintenance, administration, training and information on a number of technical supply systems, for example those that are used by local governments.

Public private partnerships combined with the high level of competence and long experience have been success factors in the development of Swedish environmental technology. An outstanding example of this is the concept “the Sustainable City — a Swedish Partnership Initiative” developed by the Swedish Environmental Technology Network, its members, the Ministry for Foreign Affairs and the Ministry of Sustainable Development.

The concept was launched for the first time in 2002 at the UN World Conference on Sustainable Development in Johannesburg.

**The global perspective**

Environmental issues are increasingly in focus. In the new EU member countries and candidate countries, as well as in major cities of Asia, the needs are enormous.

In economic terms, environmental technology is a gigantic sector and the market potential is large. The world market for pure environmental technology is estimated today at SEK 4,000 bn per year, approximately equal to the total annual gross domestic product (GDP) of the Nordic countries.

The OECD clearly singles out environmental technology as one of the most important sectors for the future. The world market for such technology is growing at 5–20% annually. The OECD estimates that by 2010 it will be SEK 6,000 bn per year.

Today around 90% of this market is found in the industrialized countries that belong to the OECD.

**Total revenues**

Swedish environmental technology enterprises account for a sizable share of the Swedish business sector. Their total revenues are estimated by Statistics Sweden at about SEK 270 bn.

In 2004, total revenues of companies working internationally were SEK 45 bn, which shows that in relation to other industries, environmental technology is very important. However, in 2004 exports accounted for only about 31% of total revenues, which means there is room for further expansion. In the same year, exports accounted for about 52% of total environmental technology revenues.

Water and wastewater treatment is the largest field of operations, accounting for 35% of total environmental technology revenues, with air pollution control accounting for 17% and waste management and recycling 15%. Companies working in renewable energy/energy efficiency improvement account for 33%.

**Strong growth in Swedish environmental technology exports**

Environmental technology exports are showing a very positive trend, with rising growth, and in 2004 accounted for more than 2% of total exports, when Swedish companies exported services and products worth nearly SEK 25 bn. In 2004, the overall value of Swedish exports was nearly SEK 1,200 bn, following a sharp rise during the 1990s.

Environmental technology exports have followed the prevailing trend in major Swedish exporting industries, with an export growth of 15% in 2004. Companies in the wind power, bioenergy and solar energy fields have accounted for a large proportion of the increase. If this trend continues, Swedish environmental technology exports will reach SEK 40 bn by 2008. If exports by large Swedish construction companies are also included, the value is considerably higher.

More and more small and medium-sized companies are internationalizing and playing a major role in this growth. Studies indicate that small companies represent a large share of the environmental technology industry.

Nearly half the companies working in this industry have fewer than ten employees and the bulk of companies (77%) have fewer than 50 employees. Fifteen percent are medium-sized companies and 8% are large companies.

**Asia and Central and Eastern Europe becoming key export markets**

The geographic dispersion of environmental technology exports coincides fairly well with that of Swedish industry as a whole. The most important markets are the other Nordic and Western European countries, which received more than half of Swedish environmental technology exports. Although Western Europe (excluding the Nordic countries) remains the largest market, Asia and Central and Eastern Europe in particular have grown in importance.

Expansion prospects for environmental technology companies are very good. More than 80% of such companies foresee good growth potential.

The largest single impediment to faster expansion is the shortage of venture capital. Many companies need an infusion of risk capital to achieve the critical mass required for further expansion.

The relatively small export share of environmental technology companies has not prevented them from being internationally active. Seventy-two percent of these enterprises do marketing outside Sweden using their own employees.

The environmental technology sector is thus one of Sweden’s most aggressively export-oriented sectors.
Participation in public tenders
Public tenders are a common method of procurement for environmental technology projects. Apart from locally financed procurements, such tenders are financed by the Swedish International Development Cooperation Agency (Sida), Swedfund, the World Bank, the European Bank for Reconstruction and Development and various EU funds. Of the environmental technology companies that have participated in international procurements, most have participated in locally financed ones (which include EU tenders).

The single most important success factors in boosting exports, according to the companies, are finding local representatives and business partners, participating in effective networks and increasing customer awareness of the sector and new technology. Access to resources and a company’s chances of financing marketing ventures are other key factors.

www.swedentech.com is the hub of this work and serves as the platform for Swedish environmental technology exports. The website publicizes and markets Swedish know-how in this sector internationally, making it easier for potentially interested parties to get into contact with the Swedish resource base.

Renewable energy
Sweden’s official target to end oil dependence by 2020 does not imply that all oil must be replaced. This instead means developing alternatives that are technologically and economically viable. These may not contribute to the greenhouse effect, however, because the most important driving force behind the official target is concern about climate and a desire to decrease the use of fossil fuels. The new government is discontinuing Sweden’s phase-out of nuclear power plants, but the two reactors already closed will not receive new operating permits.

The big challenge is to develop alternative fuels for vehicles and aircraft. In all other energy contexts where oil is used, there are already technologically functional alternatives.

There are three commercially available vehicle fuels based on renewable energy – biogas, ethanol and rapeseed methyl ester (RME). Together these account for 2 TWh, or less than 2% of Sweden’s vehicle fuel supply. However, use of these fuels is growing rapidly as a growing proportion of new cars are ethanol- or biogas-powered. In fact, during 2005 one out of fifteen cars sold in Stockholm was officially classified as an environmentally “clean” car.

Hydropower
Sweden has no shortage of resources for replacing oil. Since the early 20th century, hydropower (hydropower) has been used around the country. Today normal production totals about 65 TWh of electricity, which is equivalent to nearly half of the country’s electricity production.

Bioenergy
Even bigger than hydropower is the use of biofuels. According to official statistics, in 2004 Sweden used 110 TWh of biofuels. The country will probably pass the 120 TWh mark in 2006. Biofuel use has grown virtually every year since 1971, when use totaled 40 TWh.

In 1971 biofuels (bark and sawdust residuals) were used mainly in the pulp and paper industry. Today there are many uses. They are the most important source of energy for municipal district heat production. More than 6 out of 10 KWh for district heating come from biofuels. In 2004, total use was 33 TWh.

Biofuels are also used for electricity production and for space heating, both in the form of firewood and in processed form as biofuel pellets.

The big breakthrough for biofuel pellets occurred in 2005, when use reached 7 TWh. Nowadays there is large-scale trading in pellets, in Sweden and internationally, similar to oil trading.

Biofuel is also considered Sweden’s main strategy for replacing oil in vehicle fuel production. In Norrköping there is a factory that produces ethanol from cereal, and another factory will be completed in 2008.

Also being discussed is production of ethanol from wood-based fuels, among other things with the aid of gasification.

The big question, however, is whether there will be enough wood-based fuels if they are now going to be used on a large scale to produce vehicle fuel. This is a topic of heated discussion in Sweden, with a wide array of opinions.

In 2004, vehicle fuel use in Sweden was equivalent to 111 TWh, or about as much as the country’s energy production from biofuels. Also being used is a growing quantity of biogas extracted from such sources as wastewater treatment plants or from the decomposition of various types of organic waste. Other solutions for vehicle fuel production may also emerge. The Swedish government is investing large sums on research in this field.

Certificates and wind power
In order to support renewable electricity production, Sweden has had a system of trading in “green electricity certificates” since 2003. The system is considered to have led to 4.8 TWh in increased electricity production, mainly from biofuels. Most of this was added because industrial and district heating companies converted from fossil fuels to biofuels.

The system includes both a carrot and a stick. The carrot is that producers of renewable electricity receive a certificate entitling them to extra compensation depending on production. The stick is that electricity traders that do not sell enough renewable electricity have to pay fines. The system will contribute 17 TWh of new renewable energy by 2016.

This higher ambition level will probably lead to a major expansion in wind power. Good wind locations are available in Sweden, for example along the southern coastlines, on Lake Vänern and on the plains,
but also in mountainous areas. The wind power industry believes that in a decade or so, it can achieve an expansion of 10 TWh, which will require a monetary investment in the range of SEK 50 million.

In the starting blocks is Sweden’s largest energy company, the state-owned Vattenfall, which will build a large wind farm in the Baltic Sea between Sweden and Germany. The Swedish Parliament (Riksdag) also recently approved a law aimed at speeding up the development of wind power in Sweden.

Geothermal energy
In Sweden, geothermal and solar energy are also used in limited quantities. Since the early 1980s, the university city of Lund has derived part of its district heating supply from a geothermal source. However, recent test drilling aimed at expanding production was unsuccessful. Nearby Malmö has derived part of its district heating supply from a geothermal source. However, solar collectors and solar cells on roofs are becoming a more common sight. Sales of both are rising every year.

Solar energy
In terms of quantity, solar energy is not a major energy source in Sweden. Solar heating totals about 100 GWh and solar electricity a few dozen MWh. Nevertheless, solar collectors and solar cells on roofs are becoming a more common sight. Sales of both are rising every year. Solar energy combined with energy-efficient construction may become an important development strategy in Sweden. There are examples of “passively heated” buildings without conventional heating systems. In these buildings, heat from humans, electrical equipment and the sun accounts for 90% of heat supply. This is achieved through heat recovery, with intake air being heated by the hot air leaving the building.

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Note: The sections on environmental technology are based on studies conducted by the Swedish Trade Council/Swedish Environmental Technology Network. An English summary of their 2005 report can be downloaded from http://www.swedentech.com/docfile/76695_Summary%20.pdf

SEK 1 (Swedish krona) = EUR 0.11 or GBP 0.07 or USD 0.13 (average 2005)

* One TWh = 1,000 gigawatt hours (GWh). One GWh = 1,000 megawatt hours (MWh). One MWh = 1,000 kilowatt hours (KWh). A family in a 120 sq. m (1,300 sq. ft.) home in Sweden consumes roughly 25,000 KWh of energy per year for space heating, hot water and household electricity. In other words, one GWh is enough to supply 40 such homes for a year; while one TWh suffices for about 40,000 such homes.

Do you have any views on this SI publication? Feel free to contact us at info@sweden.se

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RENEWABLE ENERGY SUPPLY (TWH), 2004 AND 1971

<table>
<thead>
<tr>
<th>Type of energy</th>
<th>2004</th>
<th>1971</th>
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<tr>
<td>Biofuels, peat, waste</td>
<td>110</td>
<td>40</td>
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<tr>
<td>Hydropower*</td>
<td>60</td>
<td>52</td>
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<tr>
<td>Wind power</td>
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<td>-</td>
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<td>Geothermal energy</td>
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<tr>
<td>Solar energy**</td>
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** In 2004 there was little precipitation. In a normal year, production is about 66 TWh.

* Estimate.

Source: Swedish Energy Agency

SWEDEN’S TOTAL ENERGY SUPPLY (TWH), 2004

<table>
<thead>
<tr>
<th>Type of energy</th>
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<tbody>
<tr>
<td>Nuclear power***</td>
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<tr>
<td>Crude oil</td>
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<tr>
<td>Renewable energy</td>
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<tr>
<td>Other sources</td>
<td>45</td>
</tr>
</tbody>
</table>

*** Not including waste heat losses from nuclear power plants, 149 TWh.

Links to selected web sites
The Ministry of Sustainable Development: www.sweden.gov.se
The Environmental Protection Agency: www.internat.naturvardsverket.se
The Swedish Environmental Technology Network: www.swedentech.com
Swedish Bioenergy Association: www.swebio.se
Swedish Bioenergy Group: www.sed.swedishtrade.com/bioenergy
Angråström Solar Center: www.ssc.angstrom.uu.se
Solar Energy Association of Sweden (SEAS): www.solenergiforningen.se
Nordic Windpower: www.afm.dtu.dk/wind/smepr/nordic.html
Swedish Defense Research Agency: www.foi.se
Cargo & Kraft: www.cargo-kraft.se

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(Sweden’s official Internet portal) or the Swedish embassy or consulate in your country.

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