PHOTO: SVEN ROSENHALL/NORDICPHOTOS

About two percent of all the electricity produced in Sweden comes from wind power.

ENERGY:

Generating power for a sustainable future

Cutting-edge technology, a wealth of natural assets and a high proportion of renewable energy—Sweden is in the front line as the world embarks on a shift to more sustainable energy systems.

Ever since the oil crisis in the early 1970s, Sweden has invested heavily in the search for alternative energy sources. Its phase-out of oil has proceeded smoothly. In 1970, oil accounted for over 75 percent of Swedish energy supply; by 2009, the figure was just 32 percent, chiefly due to the declining use of residential heating oil.

Sweden outlined its present energy policy in 1997. The government wanted to promote "efficient and sustainable energy use and a cost-effective energy supply" that would "facilitate the transition to an ecologically sustainable society."

The Swedish National Energy Administration was set up for this and to monitor developments.

Large amount of renewable energy

Today, 45 percent of Sweden's energy supply—electricity, district heating and fuel—comes from renewable energy, which is more than in most EU countries. The reason for this is the large share of hydropower and biofuels in the energy system. Since early 2009, there has been an EU directive to promote the development of renewable energy sources. Based on the directive, Sweden has set a target to increase its share of renewable energy to 50 percent by 2020.

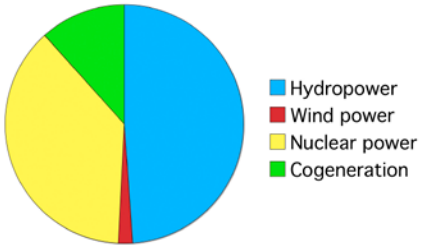
High power consumption —low emissions

Sweden consumes a substantial amount of electricity per capita (16,000 kWh per person per year). Only a few countries have higher electricity consumption. Yet Swedish carbon emissions are low compared to other countries. The average Swede releases 5.3 tons of carbon dioxide per year into the atmosphere, compared with the EU average of 8.1 tons and the US average of 19.0 tons.

The reason for this low emission rate is that about 85 percent of electricity in Sweden comes from nuclear power and hydroelectric power, neither of which generates carbon emissions.

Biofuels provide heat and power

Cogeneration, or combined heat and power (CHP), plants account for a further 12 percent of the electricity output in Sweden, and these are mainly powered by biofuels. The remaining portion of electricity, about two percent, comes from wind power.



Sweden's electricity production, 2009 (TWh).

MORE ABOUT RENEWABLE ENERGY

WIND POWER
Wind power is the energy source experiencing the greatest growth in the world. In Sweden, a gradual expansion is also underway. Since 2000, production has increased five-fold, from 0.5 to 2.5 TWh. In early 2010, there were some 1,400 wind turbines in Sweden.

BIOENERGY
In terms of land, Sweden has more forest than most other countries—58 percent compared with the global average of 30 percent. About 90 percent of bioenergy in Sweden today comes from the forestry sector. Bioenergy represents about 20 percent of Sweden's total supply of energy, most of which is used in industrial processes and district heating.

HYDROGEN
A fuel cell is a battery that is topped up instead of charged—the fuel is hydrogen and the exhaust it produces is water.

In seeking ways to manufacture hydrogen, Swedish researchers are trying to imitate photosynthesis in plants since the process requires only sunlight and water. However, it will be years before this line of research produces results.

SOLAR POWER
A breakthrough for solar cell technology can be expected once solar cells become cheaper. But as yet, the market for solar cells is fairly limited in Sweden.

WATER
Researchers from the Ångström Laboratory at Uppsala University are currently testing a new type of wave power in Lysekil, off the west coast of Sweden, using only buoys (floats) and a piston-driven generator. In the long term, wave power technology may be commercially viable.
www.angstrom.uu.se


PHOTO: MAURO RONGIONE/JOHNÉR

Solarcells are an effective, but still expensive, source of renewable energy.

Renewable electricity
In 2003, green electricity certificates were introduced in Sweden to encourage the use of renewable energy. To be certified green, the electricity has to come from wind power, wave power, solar energy, geothermal energy, biofuels or small hydroelectric plants. Power consumers have to buy a certain number of green certificates—via their electricity bills—while power producers receive a certificate for every megawatt-hour (MWh) of renewable electricity they generate. The goal is to boost renewable electricity by 25 TWh from 2002 to 2020. Between 2002 and 2009, renewable electricity increased by 8.2 TWh under the scope of the electricity certificate system, with biofuels representing about 67 percent of this and wind power 24 percent.

Fast growing energy source
Wind power has been the fastest-growing source of renewable energy in recent years. Installed capacity multiplied over the past decade. However, the rising share of wind power with its fluctuating production places considerable demands on the electricity supply grid, which must be strengthened and expanded.

Alternative fuels
Sweden puts considerable effort into developing renewable, alternative fuels. Ethanol research began in the 1980s, and Sweden is among the world leaders.

Most of the ethanol sold today is produced from grain, with varying consequences for the climate. From a life cycle viewpoint—where climate impact is measured along the whole chain from production to use—ethanol extracted from sugarcane is favored. Swedish researchers focus on the production of ethanol from cellulose, referred to as second-generation biofuels. In most cases, this is a more effective method than grain-based production. Moreover, this type of ethanol does not affect food crops. Other biofuels of interest are different kinds of biogas that can be extracted from manure and waste, among other materials.

Cleaner transportation
The European Union targets call for 10 percent of all transport fuel to be derived from renewable energy sources by 2020. By 2009, Sweden had reached 5.3 percent, in part due to increased use of ethanol. To speed up developments, a "pump law" was introduced in 2006 under which all gas stations selling more than 3,000 cubic meters (about 100,000 cubic feet) of gas or diesel per year are required to supply at least one kind of renewable fuel.

PHOTO: ULF HUETT NILSSON/JOHNÉR

Rechargeable cars
Hybrid cars, i.e. vehicles that use electrical (battery) power and fuel, are on the rise. The combination of electricity and biofuels seems promising. The next step is plug-in hybrids—cars with larger batteries charged from the power grid. In spring 2008, Volvo and Vattenfall, Sweden's largest power company, embarked on an ambitious project to produce the next generation of plug-in hybrids. The companies aim to begin mass production in 2012.

DID YOU KNOW?

SWEDEN ALLOWS NEW NUCLEAR POWER PLANTS

For several decades, the main focus of Sweden's energy policy has been to phase out the country's nuclear energy (today, three nuclear power plants with a total of ten reactors remain). But in June 2010, the Swedish parliament decided that it will once again be possible to build new nuclear power plants in the country, thus rescinding the law phasing out nuclear energy.

WORLD-CLASS POWER MARKET

Since its deregulation, the Swedish power market has become a shining example by international standards, according to the International Energy Agency. Since 1996, customers have been able to freely choose their power supplier. Today, more than 100 Swedish companies sell electricity to consumers.

ELECTRICITY TRADING

Nord Pool in Oslo, Norway, is where most power suppliers in the Nordic region buy electricity to sell to consumers. There is a spot market with prices by the hour as well as a futures market.

Power prices are largely determined by water supply, given the large proportion of hydroelectric power in Norway and Sweden. In dry years, water supply to hydroelectric plants dwindles, pushing prices up. Rainy years usually have the opposite effect.

Conserving energy in industry

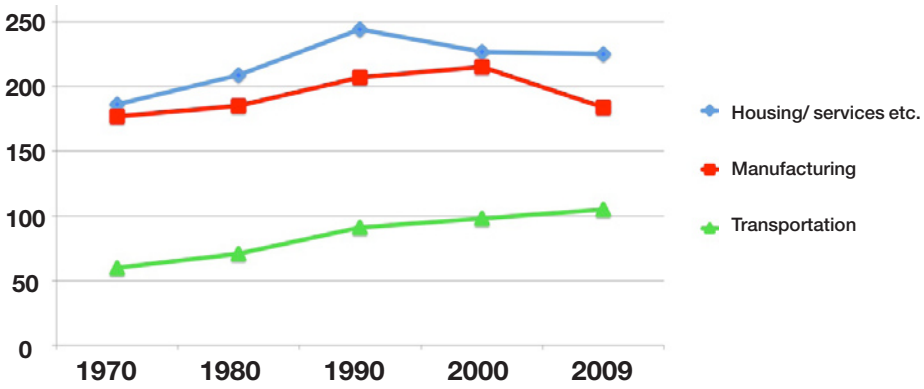
In 2005, Sweden introduced a special program designed to boost energy efficiency in industry. Under this program, the 180 or so power-intensive industries taking part are granted tax relief in exchange for drawing up energy plans and taking steps to reduce energy use. To date, the program has resulted in energy savings of about 1.4 TWh per year at a value of about SEK 500 million.

In the construction sector, the government wants a 20 percent reduction in energy use in building stock by the year 2020 (compared with 1995) and a 50 percent reduction per heated unit area by 2050. This has made energy-efficient housing a more interesting proposition. Passive houses are one example. These are built without conventional heating systems and are kept warm by the heat given off by their occupants. Extra thick insulation and intelligent ventilation systems ensure low energy use.

Since January 1, 2008, a new law on energy declarations has been in force in Sweden. Based on an EU directive and applying to all owners of private homes, apartment blocks and other premises, its aim is to promote more efficient energy use.

The government is investing heavily in information and advice for households on how to save energy. Each municipality—there are 290 in Sweden—has an energy adviser people can turn to for advice and assistance. These include replacing windows, using low-energy light bulbs, switching to different heating systems and the like. ■

Sweden's total energy consumption (TWh).



Stockholm-Arlanda is heated from below ground

Beneath Stockholm-Arlanda Airport, just outside the Swedish capital, is the world's largest energy storage unit. The underground water reserve or "aquifer"—almost two kilometers (over a mile) long—cools and heats half a million square meters (over five million square feet) of terminal space.

Cold water is pumped out of the aquifer in the summer to be used in the airport's district cooling network. Warmed-up water then flows back and is pumped underground and stored until winter, when it is needed to melt the snow in aircraft parking stands and prewarm the ventilation air in buildings. The aquifer has a volume of over two million cubic meters (about 70 million cubic feet), with water constituting 30 percent of this.

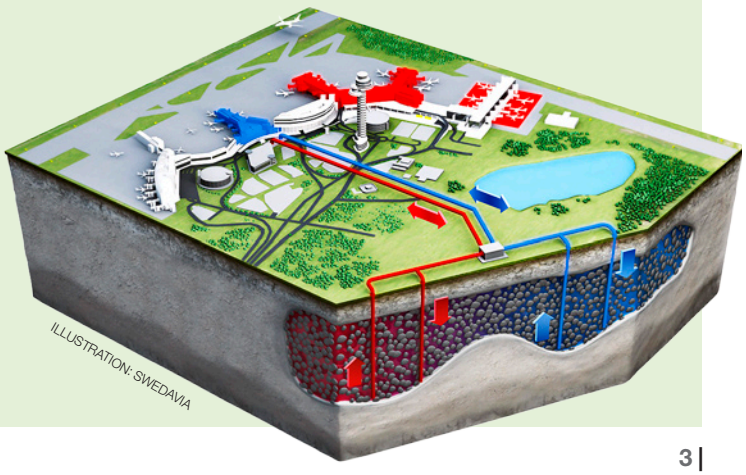


ILLUSTRATION: SWEDAVIA

DID YOU KNOW?

SWEDEN IS FUNDING CLIMATE PROJECTS

The Kyoto Protocol, signed in 1997, calls for a reduction in greenhouse gas emissions to prevent "dangerous anthropogenic interference with the climate system." Sweden takes an active part in the Kyoto Protocol's Clean Development Mechanism (CDM) and Joint Implementation (JI) programs. The Swedish Energy Agency is responsible for the programs, which include projects in China, India, Brazil and the Baltic countries.

In recent years, the Swedish Energy Agency has focused its CDM efforts primarily on countries in Southeast Asia and Africa. One example is a solar cell facility in Benin, which the agency provided funding for in the fall of 2010. The electricity generated by the solar cell plant will be distributed using Benin's national electricity grid, and annual production is estimated to be about 32,000 MWh.

The Swedish Energy Agency's total budget for CDM projects between 2002 and 2012 is about SEK 1.5 billion.

End to energy-wasting products

It started with light bulbs. Now more and more products that waste energy are being phased out through the EU's "renewable energy directive."

By setting minimum standards for various technical products, there is great potential to reduce energy consumption across Europe—and thus climate-changing emissions. Among the products that have so far been subject to stricter energy requirements—along with light bulbs—are televisions, digital boxes, circulation pumps and electric motors.

The EU's Ecodesign Directive applies to new sales and covers the entire EU. Overall, the minimum requirements on product groups entail major reductions in energy consumption. The ecodesign requirements, together with the energy labeling of products, are expected to save some 1,110 TWh within the EU by 2020 (as a comparison, Sweden's total annual energy consumption is about 570 TWh). ■

PHOTO: SAMI SARKIS/MATTON

SEK 1 (Swedish krona) = USD 0.15 or EUR 0.11 (February 2011)

Other useful links

www.elforsk.se Research and development center for the Swedish energy industry
www.energimarknadsinspektionen.se The Energy Markets Inspectorate, regulator for the Swedish electricity, natural gas and district heating markets
www.energimyndigheten.se The Swedish Energy Agency, responsible for energy policy
www.energy.eu Europe's energy portal
www.iea.org The International Energy Agency
www.managenergy.net European Commission initiative aimed at local and regional energy management agencies
www.naturvardsverket.se The Swedish Environmental Protection Agency, responsible for Swedish environmental policy
www.svenskenergi.se Swedenergy, a nonprofit organization representing companies involved in the production, distribution and trading of electricity in Sweden
www.vr.se The Swedish Research Council

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More facts can be found on
www.sweden.se

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