

# GÖTA ÄLV

A journey along one of Sweden's magnificent rivers

STRETCHING FROM LAKE VÄNERN TO GÖTEBORG'S HARBOUR AND OUT TO THE KATTEGATT, GÖTA ÄLV CARRIES MORE WATER THAN ANY OTHER SWEDISH RIVER. FOR CENTURIES, GÖTA ÄLV HAS BEEN A MAJOR TRANSPORTATION ROUTE, PARTICULARLY SINCE THE CONSTRUCTION OF THE GÖTA CANAL.

SWEDEN'S FIRST HYDROPOWER PLANT, OLIDAN, ON GÖTA ÄLV, BEGAN OPERATING IN 1910 AND LAID THE FOUNDATION FOR VATTENFALL'S HIGH TECHNOLOGY.



# THE HISTORIC JOURNEY — FROM THE ICE AGE TO THE FUTURE .

About 12,000 years ago, the inland ice receded. The climate grew successively warmer and Scandinavia, entombed under three kilometres of ice for tens of thousands of years, would soon burgeon forth. The inland ice melted quickly, retreating to the point when, after only a couple of thousand years, eternal winter was replaced by a new landscape. Meltwater followed ancient furrows, eroding mountains and transforming the face of the land. The water deposited fertile soil along the river valleys. And where the ice had released its grip, people lost no time in finding new grounds in which to hunt and gather.

The first inhabitants, hunters and gatherers, lived well on the plentiful game and fish. Soon, they also learned to farm the fertile river valleys and, eventually, that the power of the rivers could be harnessed. Waterpower was utilized as early as the 1200s. Gristmills and sawmills

were built, logs were floated downstream and the rivers became vital for transport. But their most important contribution to the development of society had yet to be realized.

With the late industrial revolution came large-scale use of electricity. For centuries, only a tiny fraction of the kinetic energy from the rivers had been utilized. Then, at the turn of the last century, engineers began to see the enormous potential of hydropower. In 1910, Sweden's first hydropower plant, Olidan, on the Göta River, began to supply power for industry and the railway. That signalled the start of the development of our rivers. Today, hydropower accounts for nearly half of Sweden's total electricity demand. In the future, hydropower will continue to play an important role, perhaps the most important role, as a renewable energy source.



The rapid melting of the inland ice contributed to the formation of river valleys and enriched the soil. For thousands of years, the rivers have played an important role in the development of society. The power of the river, once used for log driving, now accounts for nearly half of our total electricity demand.

# WATER IS ON A NEVER-ENDING JOURNEY.

Waterpower is a sensible way of using a natural eco-cycle. Water vapour, which forms when the sun warms the lakes and oceans, rises to the higher, colder layers of air, where it condenses and forms clouds. When the clouds move in over the land, they release their burden in the form of rain or snow. That rain and snow is what keeps our rivers flowing. On its journey to the coast, we take advantage of the water's potential energy. Still within the eco-cycle, the water returns to the lakes and the sea, and the process begins again. Hydropower comes from a renewable source and makes use of Nature on Nature's terms.

## **ENERGY DEMAND CONTROLS PRODUCTION.**

Electricity from large-scale production cannot be stored, but must be used the instant it is produced. That is why we control hydroelectric generation with the help of reservoirs.

During the spring and early summer when the snow melts, and even during the autumn when it rains more often, huge volumes of water are stored. We can then use this water to produce electricity during the winter months, when power demand is greatest and the rivers receive no inflow from precipitation. In a river that has been developed for hydro production, water levels are controlled very carefully. The release of water from reservoirs is determined by energy demand in accordance with regulations establishing water levels and flow rates.

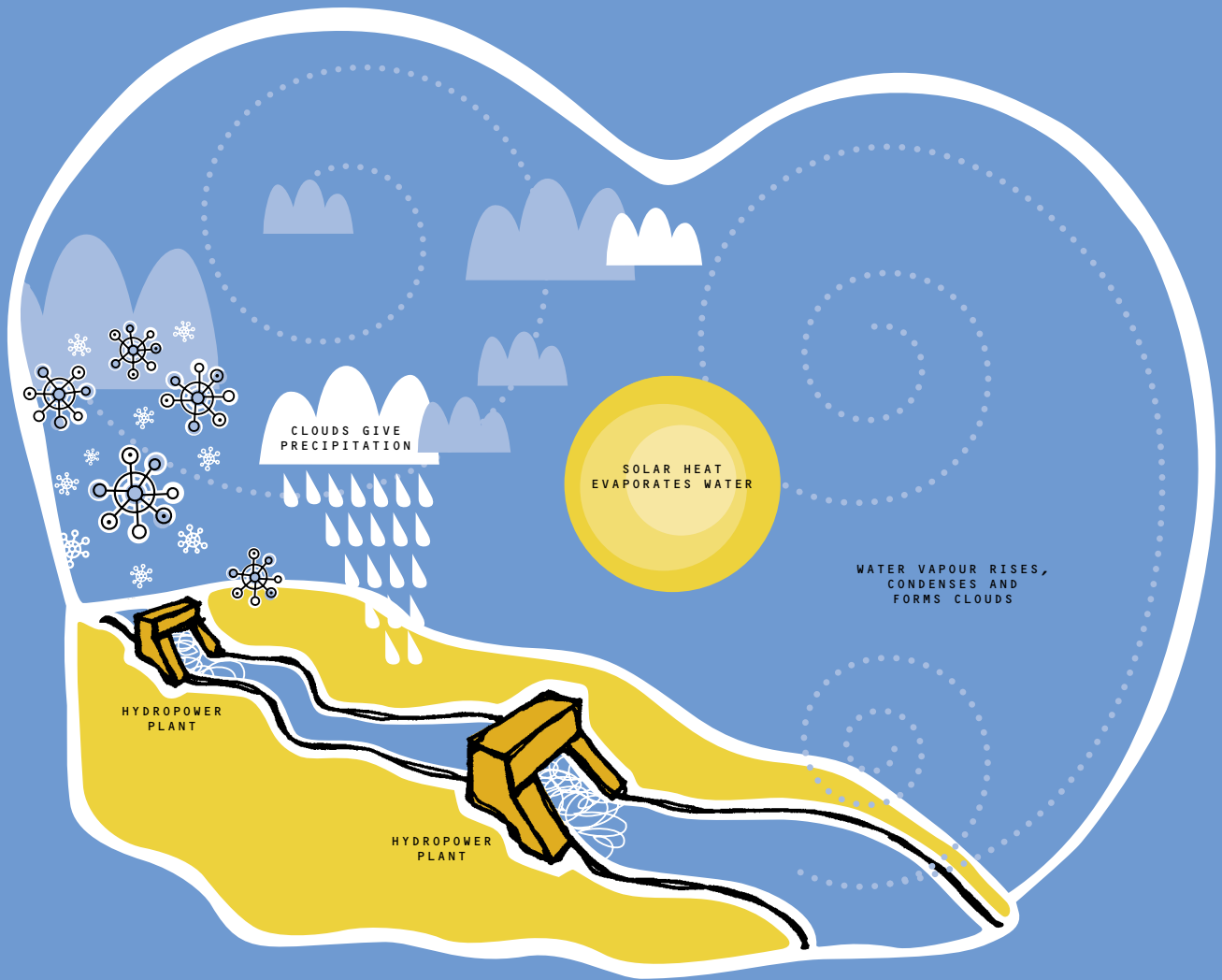
## **FOR VATTENFALL, THE ENVIRONMENT COMES FIRST.**

Hydropower is a green energy source that does not harm the air we breathe or the water in our rivers. The process creates no hazardous wastes and no emissions are discharged to the air or water. Even so,

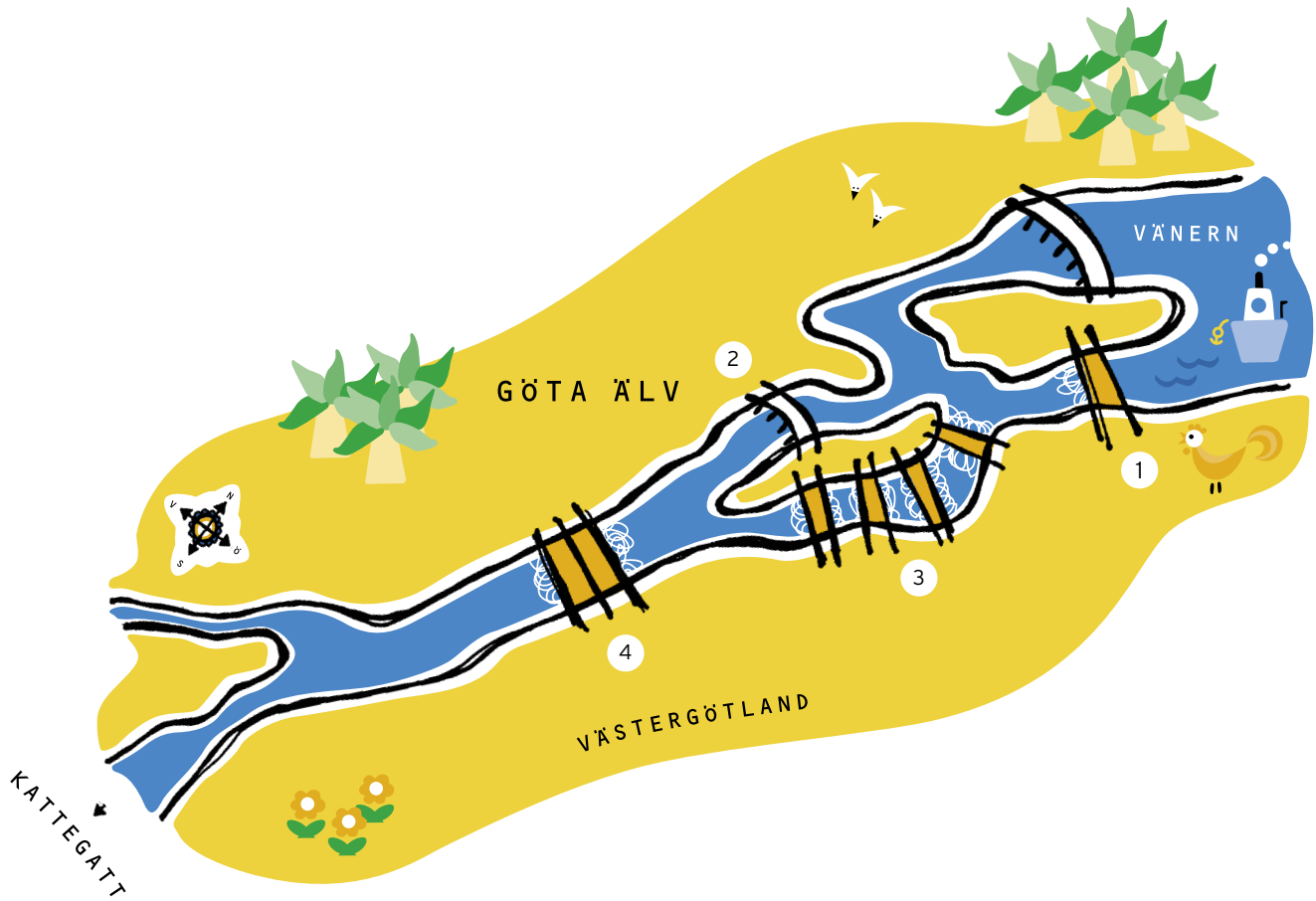


Average annual rainfall in Sweden is between 600 and 700 mm. Abisko, on the other hand, gets about 300 mm of rain per year, which is about the same as the Gobi Desert.

hydropower production does give rise to a certain degree of environmental impact. The power stations, dams and reservoirs that are essential for utilizing the power of rivers have a great impact on the flora and fauna, both upstream and downstream. The natural reproduction of salmon species is disrupted. Vattenfall is therefore working to minimize the environmental impact caused by hydropower production. Salmon ladders have been built to help the fish bypass the dams. Vattenfall also releases around 1.3 million salmon and sea trout smolt annually in order to maintain the balance of growth. Today, environmental aspects are given very careful consideration when hydro stations are renovated or enlarged. Together with other power companies, Vattenfall is also involved in several projects of which the aim is to reduce environmental impact on our regulated waterways.



THE WATER CYCLE IS ETERNAL. THE SOURCE OF ALL LIFE.  
BY USING NATURE ON NATURE'S TERMS, WE HAVE ACCESS TO A  
SUSTAINABLE, RENEWABLE ENERGY SOURCE.



#### VATTENFALL'S HYDROPOWER PLANTS ON GÖTA ÄLV

- 1 Vargön
- 2 Hojum
- 3 Olidan
- 4 Lilla Edet



#### HYDRO TALK

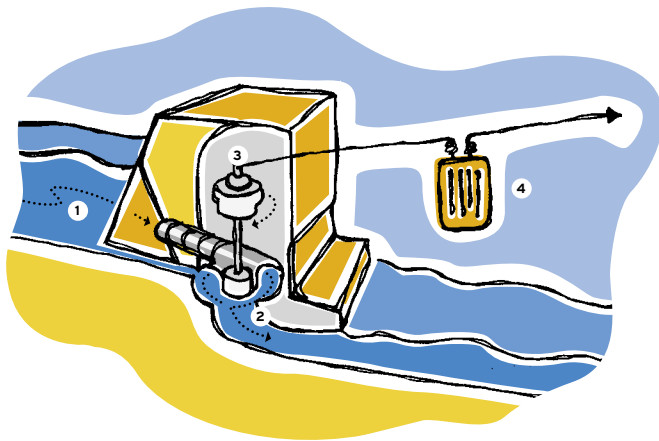
How much energy does it take to light a 60-watt light bulb for 24 hours, to vacuum for one hour, or to watch a full-length film on TV?

Look at your household electrical appliances. Somewhere you'll find a label stating power requirement (in watts). If you multiply the power in kW by the number of hours you use the appliance, you get the total power requirement (in kWh).

**Example:** 60W light bulb for 24 hours:  
 $0.006 \text{ kW} \times 24 = 0.144 \text{ kWh}$ .

# THE ENERGY JOURNEY — FROM RIVER TO CUSTOMER.

The amount of energy that can be converted is directly related to two factors: head and flow. Head is the difference in height between the water surface above and below the dam. Flow is the amount of water passing the turbine per unit of time. Since power is the product of head and flow, a higher head and a higher flow give a higher output. The energy utilized is referred to as potential energy. Quite simply, we make use of the height difference between two water surfaces to drive a turbine, which in turn drives a generator. The generator converts mechanical kinetic energy from the turbine into electricity. A transformer steps up the voltage and the electricity can be distributed around the country.



## 1. Reservoir

Water is dammed up to create higher head and for storage, so that power production can be controlled.

## 2. Turbine

On its way to the lower level below the dam, the water passes through a turbine. The turbine shaft, driven by the flowing water, drives a generator.

## 3. Generator

The generator converts mechanical energy from the rotating turbine shaft into electricity.

## 4. Transformer

In order for the transmission lines to carry the electricity efficiently over long distances, the low generator voltage is increased to a higher transmission voltage by a step-up transformer.



## VATTENFALL'S HYDROPOWER PLANTS ON GÖTA ÄLV

Station	Starting year	Normal annual prod. GWh	Max. output MW
Vargön	1934	165	34
Hojum*	1941	1,260	172
Olidan*	1910	1,260	77
Lilla Edet	1926	210	43

\* The combined normal annual production of Hojum and Olidan is 1,260 GWh.

GWh = Gigawatt hours

MW = Megawatts

Vattenfall is sole owner of all hydropower plants on Göta älv.

# YOUR OWN JOURNEY OF DISCOVERY ON GÖTA ÄLV.

Göta älv originates in Lake Vänern, Sweden's largest lake. The river has always been a major transportation route, but its importance increased with the construction of the Göta Canal, which linked the east coast with the west coast. Göta älv carries the greatest volume of water of any river in Sweden and its 44-metre head is mainly concentrated on the river's upper stretch, at Vargön, Trollhättan and Lilla Edet. The interactive Kungajakt Museum in Hunneberg, at Vänern's outflow, is well worth a visit. Here, you can be "king of the forest" and see how people lived from the Stone Age to the present. Farther downstream, in Trollhättan, the release of water at the power station is a magnificent spectacle. Each summer, during Fallens Dagar (Falls Days), about 120,000 people visit Trollhättan. Take the opportunity to visit SAAB's automotive museum, which has about 60 cars on display. Hydropower, the Trollhätte Canal and SAAB put Trollhättan on the map.



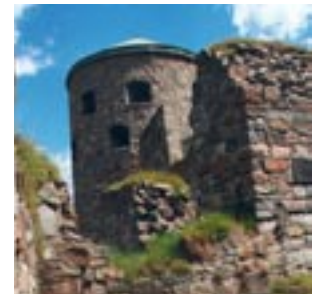
**The Trollhätte Canal**, where maritime traffic bypasses Trollhättan.



**Göta älv** is regaining its reputation for good salmon fishing.



**Göta älv** has long been important for transportation.



**Bohus Fästning**, unconquered for 400 years.

## **A STRONG FORTRESS GAVE BOHUSLÄN ITS NAME**

Göta älv was once one of the country's best salmon fishing rivers. To improve conditions for the salmon population, Vattenfall built two salmon ladders at the Lilla Edet power station. Here, 30,000 smolt are released each year. Thanks to these efforts, catches have increased considerably, much to the delight of anglers. A visit to Lödöse Museum is a journey back in time, to when Lödöse was one of Sweden's most important towns. Often referred to as "Old Göteborg", Lödöse lost its town charter in 1646. Another point of historic interest is the fortress of Bohus Fästning, which gave Bohuslän its name. The fort was attacked fourteen times, but its sturdy walls withstood the invaders. It was not until the people of Kungälv decided to demolish the fort in order to build a road with the stones that Bohus Fästning finally surrendered. Today, Bohus Fästning is a popular tourist attraction.



**1** Kungajakt Museum,  
Älgens Berg, Bergagården

Located in Hunneberg is Älgens Berg, an interactive museum for people of all ages. Get to know the king of the forest at close range, follow social development from the Stone Age to the present and see gold artefacts from Vittene.

**2** Trollhättefallen and Falls Days

During the summer, the floodgates are opened at least three times a week. A fantastic sight, right in downtown Trollhättan. Don't miss the illuminated evening discharges or Fallens Dagar, which attracts around 120,000 people annually.

**3** SAAB Automotive Museum

Whenever Trollhättan is mentioned, SAAB always comes to mind. You'll see 50 years of automotive history, from the first SAAB to the latest. About 60 cars from the 100-plus collection are on show.

**4** Lilla Edet hydropower plant  
and salmon farm

To help salmon swim upstream, two salmon ladders were built at the Lilla Edet power station. Here, during the spawning season, you can watch the salmon jump. Near the power station, Vattenfall also releases 30,000 smolt each year to maintain salmon stocks.

**5** Lödöse Museum

Lödöse is considered Göteborg's predecessor and one of mediaeval Sweden's most important towns. The museum features permanent exhibits of mediaeval Lödöse, as well as temporary exhibits on varying themes.

**6** Bohus Fästning

Norwegian king Håkon V erected Bohus Fästning in 1308. The fort was attacked no fewer than fourteen times, but withstood the invaders. Visit the fort that gave Bohuslän its name.

# VATTENFALL'S JOURNEY — FROM HYDRO PIONEERING TO HIGH-TECH GENERATION.

As early as 1909, Vattenfall was producing electricity from the Trollhätte Canal and waterworks. Sweden's growing industries, railways and cities had an insatiable hunger for inexpensive energy. The power stations at Porjus, Olidan and Älvkarleby were built mainly to supply the railways with electricity. This was the start of hydropower development and a major step forward for Swedish industry.

## **HYDRO, NUCLEAR AND WIND POWER.**

Today, by means of hydro, nuclear and wind power, as well as with fossil fuels, biofuels and waste, Vattenfall produces both electricity and district heat. In Sweden, hydro and nuclear energy are the basis of electrical power production. We operate three nuclear power stations and about a hundred hydropower plants. With forty wind-power plants, we are one of Sweden's largest producers of wind-generated electricity.



## **ONE OF EUROPE'S LEADING ENERGY COMPANIES.**

Deregulation has enabled Vattenfall to expand its market area over a large part of Europe. Our goal is to become one of Europe's leading power producers. We have the capacity and know-how to supply our customers with energy, mainly electricity and heat, that is economical, makes good sense environmentally and is tailored to individual needs. We give our customers value for money by providing energy for quality of life, heat, light, comfort, safety and security, with reliability and good resource management. Now and in the future.

## **EFFICIENCY AND ENVIRONMENT.**

We are making an ongoing effort to improve efficiency and the environment in our production facilities, always keeping human health and wellbeing, working environment and safety in focus. Vattenfall works in compliance with recognized environmental management systems.

Our customers can now choose to take delivery of environmentally friendly electricity from our renewable power sources. We guarantee that 95% of this electricity is from hydropower sources and 5% is from wind power. We also offer VattenEi EPD, which means that the electricity is produced on the Lule and Ume Rivers. EPD stands for Environmental Product Declaration.

We are committed to the environmentally sound development of future energy alternatives and to making Vattenfall the customers' number-one choice where both economy and environment are concerned.



POWER YOU CAN RELY ON



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