

# LULE ÄLV

A journey along one of Sweden's magnificent rivers



FROM THE NORWEGIAN BORDER  
DOWN TO THE BAY OF BOTHNIA.  
FROM THE MOUNTAINS AND  
GLACIERS, OVER PINE HEATHS AND  
MARSHLANDS, THROUGH ANCIENT  
SPRUCE FORESTS AND CULTURAL  
LANDSCAPES.

LULE ÄLV'S JOURNEY BEGINS IN  
WORLD HERITAGE LAPONIA IN THE  
WEST AND ENDS PEACEFULLY IN  
THE EAST, IN ONE OF SWEDEN'S  
MOST BEAUTIFUL ARCHIPELAGOS,  
NEAR WORLD HERITAGE  
GAMMELSTAD.



# 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.

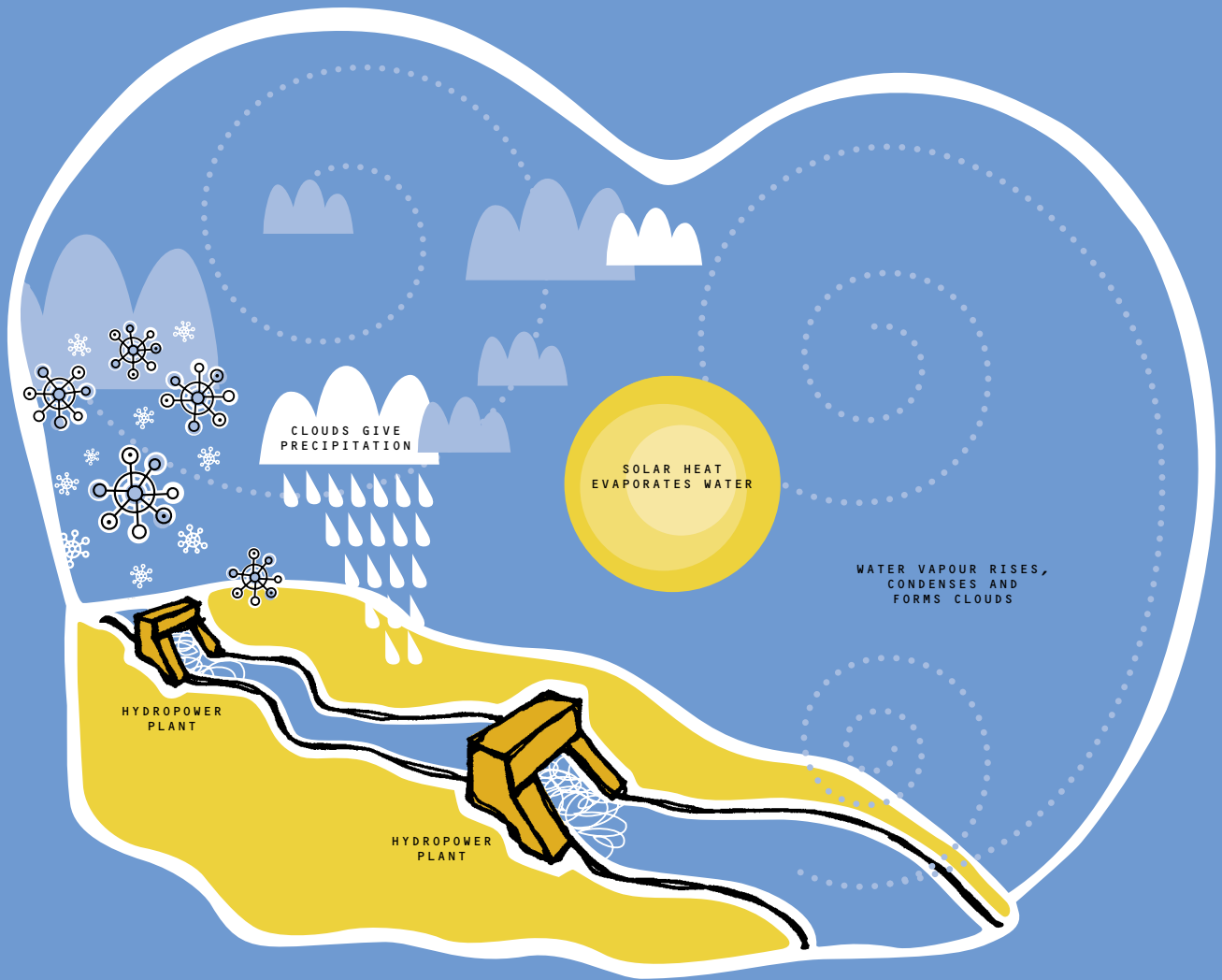
## **FOR VATTENFALL, THE ENVIRONMENT COMES FIRST.**

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,

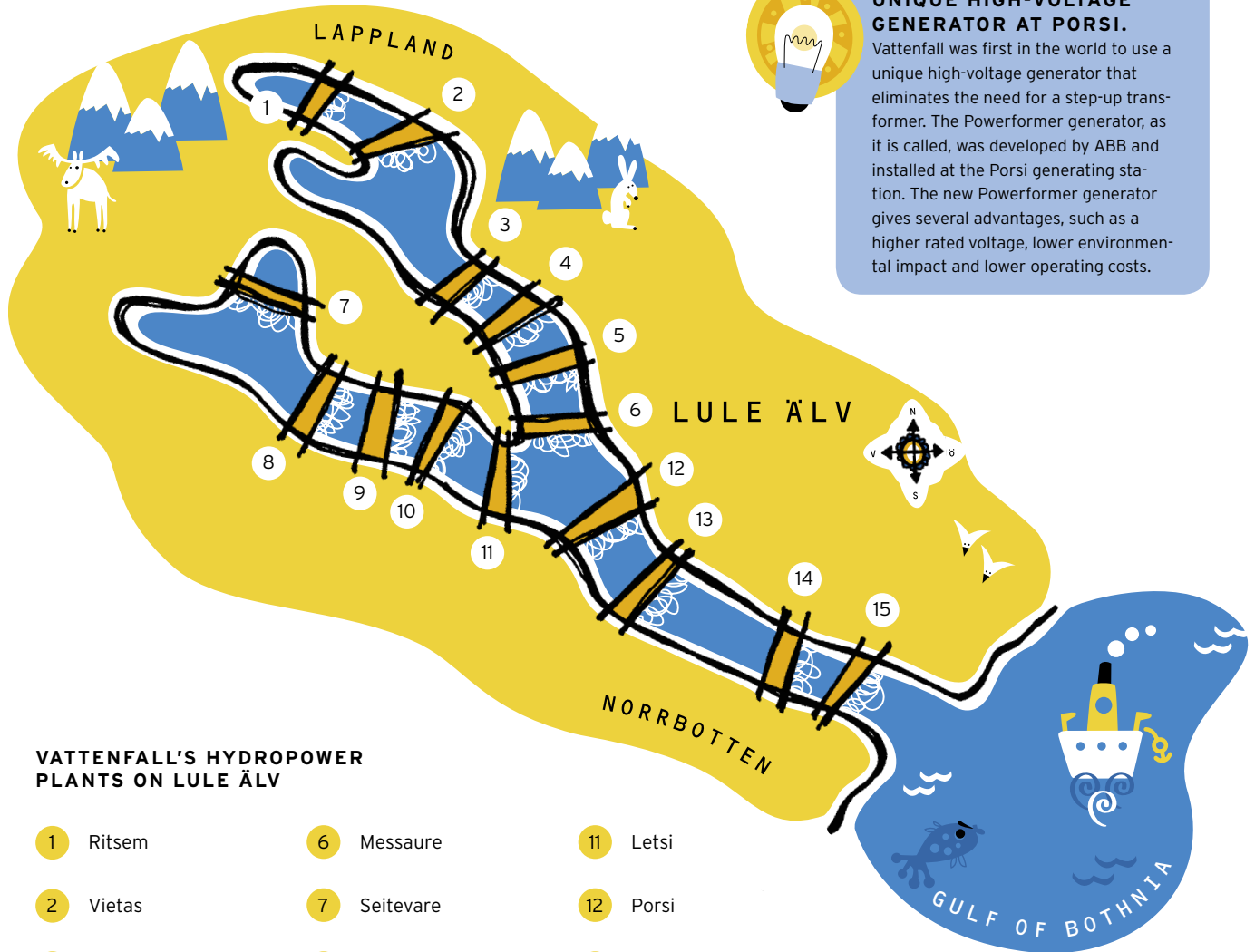


Average annual rainfall in Sweden is between 600 and 700 mm. Abisko, on the other hand, gets about 300 mm of rain per year, which is about the same as the Gobi Desert.

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.



### UNIQUE HIGH-VOLTAGE GENERATOR AT PORSI.

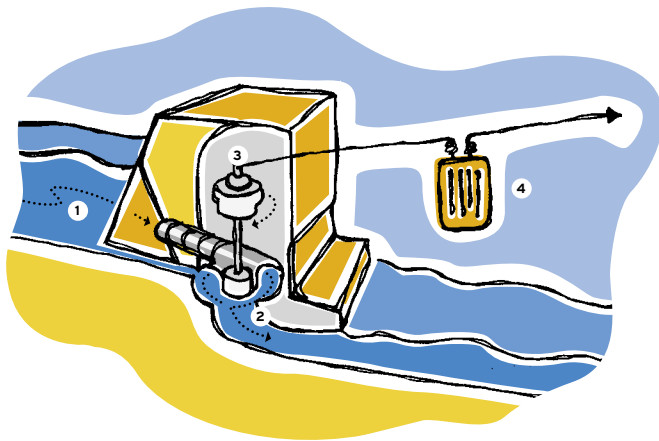
Vattenfall was first in the world to use a unique high-voltage generator that eliminates the need for a step-up transformer. The Powerformer generator, as it is called, was developed by ABB and installed at the Porsi generating station. The new Powerformer generator gives several advantages, such as a higher rated voltage, lower environmental impact and lower operating costs.

### VATTENFALL'S HYDROPOWER PLANTS ON LULE ÄLV

- |               |             |             |
|---------------|-------------|-------------|
| 1 Ritsem      | 6 Messaure  | 11 Letsi    |
| 2 Vietas      | 7 Seitevare | 12 Porsi    |
| 3 Porjus      | 8 Parki     | 13 Laxede   |
| 4 Harsprånget | 9 Randi     | 14 Vittjärv |
| 5 Ligga       | 10 Akkats   | 15 Boden    |

# 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 LULE ÄLV

Station	Starting year	Normal annual prod. GWh	Max. output MW
Ritsem	1977	481	320
Vietas	1971	1,123	320
Porjus	1975	1,233	465
Harsprånget	1951	2,131	977
Ligga	1954	791	324
Messaure	1963	1,827	442
Seitevare	1967	787	225
Parki	1970	85	20
Randi	1976	226	86
Akkats	1973	565	158
Letsi	1967	1,850	456
Porsi	1961	1,145	280
Laxede	1962	885	200
Vittjärv	1974	175	30
Boden	1971	455	78

GWh = Gigawatt-hours

MW = Megawatts

Vattenfall is the sole owner of all hydropower plants on Lule Älv.

# YOUR OWN JOURNEY OF DISCOVERY ON LULE ÄLV.

The water flows through vast expanses of pristine wilderness in Laponia - the gateway to the high country. Several hundred kilometres downstream, the river broadens where it discharges into the Bay of Bothnia. A journey along Lule älv takes you to many exciting and beautiful places.

Laponia, a UNESCO World Heritage area, is a natural and cultural treasure that includes Stora Sjöfallet National Park, about a hundred glaciers and northern Europe's most extensive marshlands. Around Porjus, which played an important role in the country's industrial development, are the habitats of unique flora and a rich variety of bird species. Harsprånget, below Porjus, has the highest rated output of any hydroelectric generating station in Sweden and produces as much as 2,131 GWh in a normal year. A little further downstream, Muddus National Park is the site of the country's largest contiguous virgin forest.

## EARLY DWELLING PLACES IN NORRBOTTEN

At the confluence of Lule älv and its main tributary, people settled over 6,000 years ago. Archaeological digs around Vuollerim reveal evidence that northern Sweden was inhabited thousands of years ago. Just like Norrbotten's early hunter-gatherers, modern-day anglers find many excellent fishing spots along Lule älv. The Suorva Reservoir offers fine char fishing, and below the Boden power station, enthusiasts gather year-round to land record-large salmon and sea trout in one of Sweden's best fishing waters.

The Sami and Mountain Museum, Ajtte, in Jokkmokk, is a great place to experience the Lule River Valley's rich cultural heritage. And close to where the river's journey ends at the Bay of Bothnia, World Heritage Gammelstad Church Village and open-air museum Hägnan are very popular attractions.



**Laponia** - gateway to the nature and culture of the high country.



**Porjus**, site of an old power station.



**Ajtte** gives you the chance to discover the Sami culture.



**World Heritage** Gammelstad Church Village and medieval church.



**1** World Heritage Laponia  
- gateway to the high country.

One of Europe's last remaining wilderness areas and a living cultural landscape of the Sami people. Porjus, at the entrance to Laponia, has its own fascinating history. This is the site of one of Sweden's first hydropower plant. Visit the new station and see an exhibit of the old one from 1910.

**2** Porsi/Messaure

Porsi, with its unique Powerformer generator from ABB, is Sweden's most modern hydropower station. Around the Porsi and Messaure power stations are several unique natural environments that provide habitats for some twenty rare plant species and rich and varied bird life. Vattenfall designated Porsi its first protected area in 2000. Messaure was made a protected area in 2001.

**3** Museum at Vuollerim and Vattenfall's control centre

During the 1980s, archaeologists uncovered the Stone Age dwelling site at Älvnäset in Vuollerim. Today, their discoveries are on display at the archaeological museum Vuollerim 6000 Years. Vuollerim is also the site of Vattenfall's centre for monitoring and control of hydro-power operations on Lule älv.

**4** Ajtte Sami and Mountain Museum  
in Jokkmokk

Discover the Sami culture and way of life. Ajtte gives you an insight into how the Sami lived in harmony with nature. Exhibits, bookshop and souvenir shop with authentic handcrafted Sami items.

**5** Heden fish farm /  
Boden power station

Each year, Vattenfall releases around 1.3 million salmon and sea trout smolt into Swedish rivers. The Heden fish farm in Boden accounts for about 40% of the stocks. Perhaps that is why the sea trout fishing downstream from the Boden power station is some of Sweden's best.

**6** Gammelstad Church Village

World Heritage Gammelstad Church Village, with its 400 cottages grouped around the medieval church, is an excellent example of a northern Scandinavian church village. Don't miss the chance to visit open-air museum Hägnan for a cultural-heritage journey through time back to the 1300s.

# 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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