

# WATER AND WIND

## *The energies of nature*

ENGLISH



### WATER AND WINE

#### *The energies of nature*

The water of rivers and the wind were the first natural forces used by humans. In order to be used, water has to be channelled or dammed, and wind requires a surface which opposes resistance to it.

The rivers of Catalonia have been exhaustively harnessed throughout history, with the installation of mills and, later, river factories.



### *Evolution of the water wheel*

The horizontal paddle wheel or Greek mill was the earliest wheel used (2nd century BC - 1st century AD). It was used to grind grain and operated without gears.

The Roman engineer Vitruvius (1st century AD) was the first to design a vertical wheel with gears which was much more efficient but did not become widely known until the Middle Ages.

During the 18th century, the need to increase the efficiency of wheels led the English engineer J. Smeaton to carry out theoretical and practical studies to increase this.

However, it was B. Fourneyron's invention of the turbine (1827) which allowed hydraulic energy to be used for the needs of the new industry.

## MILLS, WHEELS AND TURBINES



### THE WATER WHEEL AND FLOUR MILLS

*In Catalonia, as throughout the Mediterranean region, the horizontal wheel without gears was used to grind flour*

Flour mills began to be developed in Catalonia in the Middle Ages. A head - difference in water level - was indispensable to drive the wheel, and small dams were therefore built. The output of the mill depended entirely on rainfall and the flow of the river.

#### *"Arribar and moldre"*

The flour mill signified important savings in time and work.

It brought the figure of the miller into being. The miller ground the flour, receiving a part in payment. A mill would serve some 50 neighbouring farms.



### THE WATER WHEEL AND FLOUR MILLS

*Paddle wheels and floating mills were installed on rivers with large flows such as the Ebro*

Mills could be put out of action if water levels rose or fell greatly. A solution to this was the construction of floating mills with one or two wheels which were moored to the riverbank.



### THE WATER WHEEL AND ITS NEW MECHANISMS

*Sawmills began to proliferate in the valleys of the Pyrenees and Pre-Pyrenees, taking advantage of the strong current and sharp falls.*

*In the Pallars Sobirà and other Pyrenean districts, almost every village had its sawmill for making planks. These mills used vertical rollers with wooden paddles. Many sawmills continued to operate until the 1970s.*

Paddle wheels were also used for forge hammers and wool fulling mills



### THE WATER WHEEL AND INDUSTRIALISATION

*The bucket water wheel was used to move the first industrial machines.*

The vertical bucket wheel was the engine of the first industrialisation. It gave greater efficiency and improved use of water in irregular rivers and rivers with low flow. It was known as far back as Roman times, but its use did not become widespread until the expansion of such manufacturing sectors as the paper and textile industries, previous to industrialisation.



### THE WATER TURBINE AND INDUSTRIALISATION

*The turbines which drove the shafts of Catalan factories*

The Fontaine turbine was a variant of the Fourneyron turbine, adapted to rivers with irregular flows typical of the Mediterranean region. It had a regulator which adjusted the number of water inlet holes to flow variations.

The firm of Planas, Junoy, Barné i Cia, of Girona, began to make turbines in 1858 under the patent of the Fontaine company, quickly conquering a large market throughout the Iberian Peninsula.



### THE WATER TURBINE AND INDUSTRIALISATION

*The efficiency of turbines increases*

The need for more efficient turbines soon led to technical improvements.

In Francis turbines, the water entered through the volute, flowed between fixed guide vanes and moved the central runner, which had curved vanes to increase efficiency.



### THE WATER TURBINE AND INDUSTRIALISATION

*Catalan industry returns to water, abandoning the*

*"English" model of industrialisation*

In order to operate, river factories needed to install turbines and to build canals and dams.

From the 1860s, when the hopes placed on local coal had been dashed, the rivers of Catalonia began to be used as a source of cheap energy. The railways were indispensable for transporting raw materials and finished products.

#### *The industrial colònies (industrial settlements)*

The factories set up along the rivers of Catalonia brought the workforce to them. The industrial colònies were characterised by the proximity of the workers' homes to the factory, forming a settlement including church, social services such as the co-operative store, school and civic centre, the entire site dominated by the house of the owner.

## THE WIND

*The domination of two new converters: the sailing ship and the windmill made wind power available to people.*

### CATALONIA: MORE WATER THAN WIND

*The widespread use of hydraulic energy meant that wind power was used little in Catalonia.*

Only in areas with intense, though irregular, wind conditions were pump mills built from the 19th century on.

### DIFFERENT WAYS OF USING THE WIND

The earliest records of the existence of windmills date back to the 7th century on the high plateaux of Iran, where regular winds predominate.

The axis was vertical and there was no mechanical transmission.

They were used principally for grinding grain and pumping water for irrigation.

The origins of the windmill in Europe are unclear. However, whether thanks to the Islamic countries or in a wholly independent way, windmills began to spread across Europe in the 17th century.

Technical advances allowed the mill to be positioned according to wind direction. Solutions included making the entire structure rotary (post mills) or building a mobile cap (tower mill).

## APPLICATIONS OF WIND POWER



### THE SAIL

*The Latin sail was used in Catalonia for fishing and coastal trading before the introduction of the internal combustion engine*

The Latin sail allowed ships to close haul more than with square sails. Characterised by its triangular shape, it is bent from a yard-arm which crosses the main mast at an angle. Traditionally used in small boats for fishing and making short voyages.



### GRINDING GRAIN

*The earliest function of windmills was to grind grain.*

In the Balearic Isles, where surface waterways are scarce and winds highly regular, windmills

became widely used, mainly to grind grain. In Catalonia, on the other hand, the use of water power limited the spread of windmills to more marginal zones.



### DRAINAGE

*Industrialisation, with the use of new materials and technologies, produced more efficient mills.*

Smeaton was the first to use cast iron in mills, in the mid-17th century. At around the same time, Edmund Lee introduced the tailpole, which automatically oriented the axis of the sails in the direction of the wind. Various construction problems, however, delayed its widespread use until the mid-19th century. The new windmills, better adapted to intermittent winds were quickly adopted in Catalonia, principally for drainage.