

A SHORT HISTORICAL REVIEW OF RENEWABLE ENERGY

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Summary

An historical background is always of importance. Ideas are not new. They have been

expressed in the past and applied again and again according to the development of technical means. The efforts of the pioneers to capture the energy of the sun and the scientific description of the physical properties and of the primitive applications of each period are briefly reviewed. One can see that even wind energy, geothermal energy and the power of the waters were observed, described and explained correctly and trials were made to transform this power into useful energy, by the primitive technical resources available in ancient times.

1. Introduction

1.1. The History of Renewable Energy Achievements

A historical review, even a brief one, is not always an easy task. There are many uncertainties and few, very scarce documents, not easily accessible. Nevertheless historical references, and in general historical events that promoted science and technology are of great importance to mankind. Old knowledge may help to adapt, sophisticate ideas and philosophical thoughts about physical phenomena, to the knowledge of our time, and find ways for applying these ideas using the modern technological achievements. It is obvious that many good ideas found no application due to technological limitations at the time they were expressed.

In this part of the Encyclopedia the historical events are addressed to the natural forces known today as "renewable energies". These energies are applied directly to the desalination methods and/or they are potential sources for large scale desalination plants. The historic review starts with early philosophical thoughts about the natural forces and physical phenomena, and continues with the progress made by the scientific explanations given by ancient philosophers, until the sophisticated achievements and applications of our times. Emphasis is given to those achievements whose impact on civilization and technological progress appears more significant. Units, if they exist, are given in their original symbols, or expressions with the IU System in parentheses.

Of all natural phenomena, these related to the renewable energies, such as intensive solar radiation, destructive phenomena, such as floods, and volcano eruptions, impressed early mankind, who was unable to explain them - and thus in many cases believed them as Gods. Little by little the philosophers, thinking deeply, observed these natural phenomena and discovered that natural forces could be trapped and utilized for the benefit of their families or their nations.

1.2. The Set-up of this Historical Review

The present review deals only with the historical development of the renewable energies and the progress made over the centuries to exploit and to convert these energies into a usable form, using the limited tools or machines of earlier times through to our modern, technology rich, time. Emphasis is given mainly on the technological achievements that promoted methods, devices and practical applications, that founded the basis of the modern industry.

The history of desalination is described by Dr J. Birkett in Chapter: The History of

Desalination before Large-Scale Use. In this part only the history of solar distillation, the solar driven desalination plants, from the energy supply point of view, and the particular cases connected to the coupling of the energy plants to the desalination plants are described.

2. The Renewable Energies in the Antiquity

2.1. From Legends to the First Written Documents

Tracing old references, when available, one can see that natural forces, the so-called renewable energies, were known to mankind from the very early times of the pre-historic period. Energy was used by man to survive the ice ages and, in some degree also for comfort. Later more energy was needed to establish civilization in the small communities of the antiquity. There exists no written references of the foggy pre-historic periods, but only elegant legends, that have been promoted orally through many generations and tell us more than any written document.

Such legends tell about the first energy source given to humanity: Fire. Prometheus, a Hero of Greek mythology stole the fire from the Olympian Gods, and brought it from heaven down to earth. This action was considered by the Gods as criminal, thus he was punished cruelly. This is the first reference of energy use on the earth. The use of fire may be identified with the dawn of mankind. It was used by early man only when lightning set fire to woods or dried straw, and as an energy was uncontrollable. Later, humanity was able to produce controlled fire by using tinder and flint, but was also able to preserve this fire for further use.

Natural forces were inexplicable to early man, therefore were adored as powerful Gods well known from the mythology of various ancient nations. Tracing early history one discovers that almost all known civilized nations adored the sun as a God. It was the most powerful God of all time. Greek mythology has one or more gods for every natural force, or renewable energy. Aeolus was the top god of winds and had eight sub-gods helping him to arrange the direction of the winds. Poseidon was the God who governed the waters especially the oceans and Vulcan was the God that governed the earth's heat. The conventional fuels, oil, gas and coal were not known to ancient people as energy sources.

Since the time of Prometheus, mankind looked to the sun as a source of energy and heat, though other renewable energies were also known, such as wind energy. The tremendous power of the Sun impressed and the same time frightened naive ancient peoples. Antiquity depended directly on the Sun for their food, warmth and light, and we must not forget that also even today our own lives depend directly on sunlight.

3. The Power of the Sun

3.1. The Dawn of the History

To our modern times, the sun is a rather small star among the trillions of stars in our galactic system. In antiquity the sun was looked at in another way. Mythology tells

about Gods and Heroes that were identified with the sun - Apollo, the God of beauty and music and even Zeus the master of the Olympian Gods, served as sun Gods, as did "Helios" the God-Sun. In Egypt the sun was adored as Aton, one of the most important Gods of the Egyptian Pantheon. In South America the Incas dedicated to him many temples, and the Aztecs built the well known Pyramid of the Sun, located near Mexico City. Being a God, the sun was celebrated by many poets, who dedicated to him hymns and poems, such as the following translated poem of the National Greek poet K. Palamas:

Sun, you, inexhaustible source of life,
wonderful picture of beauty and crown of the infinity before the march of legions of
gods has started.
You were considered by ages as the first and unique God.
And again you will be the last God to illuminate
like a funeral candle the frost of the last religion.

3.2. The Capture of the Sun's Radiation

3.2.1. Antiquity to Middle Age: The Philosophers

The greatest achievement of antiquity was by the Greeks at the beginning the 6th century BC. One can say that the Greeks discovered science itself, which led to dramatic developments of engineering, starting with the pioneer Thales of Miletus who concluded that all things evolved from water.

The oldest large scale application of solar energy is the burning of the Roman fleet, in the bay of Syracuse, Sicily, by Archimedes (287 to 212 BC). He was a well known Greek mathematician and philosopher, but his scientific invention was really a destructive war affair. His book on "Mirrors" has been not rescued (Delyannis 1967). The oldest reference to this event is by the Greek physician Galen (Γ α λ η ν ο ς 129 to 201 AD), in his book "De Temperamentis" (Delyannis 1967). Later, the Byzantine writer and poet John Tzetis (1110 to 1180 AD) in his book "Thousents" (Χ ι λ ι α δ ε ς), Vol. 3, describes the "burning flat mirrors" by Archimedes to repulse the Roman fleet (Delyannis 1967). The same century (11th to 12th) the Byzantine writer John Zonaras, in his book "Chronicle" (Χ ρ ο ν ι κ ο) Vol. 2, describes also the "burning mirrors" used by Archimedes and a similar technique performed in Constantinople by Proclus, who burned the war fleet of the enemies besieging Byzance (Delyannis 1967). The same historical event, that impressed many scientists, is described by the Polish mathematician Vitelio (13th century) in his book "Optics, " Vol. 5, issued in 1551 (Delyannis 1967). He states:

"The burning glass of Archimedes composed of 24 mirrors, which conveyed the rays of the sun into a common focus and produced an extraordinary degree of heat. "

Later, the story was criticized as a myth because at that time there was no sophisticated technology to manufacture special mirrors. Legends refer that a group of soldiers holding flat plate mirrors were arranged by Archimedes in an almost hemispherical position to form a large concave mirror.

3.2.2. Renaissance to the 20th Century. The Founders

After a long period of dormancy during the Middle Ages solar energy once again gained widespread interest and attention. The first steam engine was developed by Thomas Newcomen who completed the engine in 1712 after many years of experimental work. A sketch of this engine is given in Figure 1. It was used in mining engineering. In 1765 the Scottish engineer James Watt (1736-1819) working to improve a small Newcomen atmospheric steam engine conceived of separating the steam and the condensing chambers. This idea became the major feature of the first economical steam engine and thus the industrial revolution started. The start of the industrial revolution also started the need for more coal for energy purposes, creating also, unfortunately, environmental pollution. Many scientists at that time were thinking about using the renewable energies, establishing the new solar energy era, which started about the 18th century. The interest revived by the well known French naturalist and philosopher G.L.L. De Buffon (1747-48). Buffon reported a new invention which was called "hot mirrors burning at a long distance. " At the same time many inventors attracted by the potentialities of the conversion of solar radiation into mechanical energy started experimenting with solar applications. The attempts were more sensational than practical but nevertheless, many of these experiments were important to the development of solar applications.

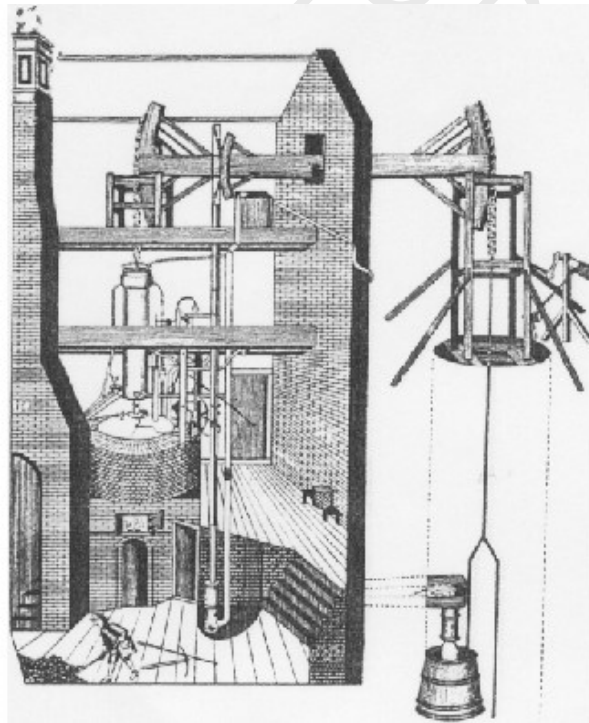


Figure 1. The Newcomen type steam engine, invented and erected by Thomas Newcomen and Captain Savery at Dudley Castle in 1712 (Dickinson 1969).

One of the earliest references on solar furnaces is by J. De Cassini (1847) who describes the use of metal or glass concave mirrors to be used in metal melting. A description of the first experimental furnace by using a "big burning glass, " is given by the well

known French chemist L. Lavoisier (1782), the founder of modern chemistry. The picture of this very early solar furnace used by Lavoisier in 1774 is presented in Figure 2.

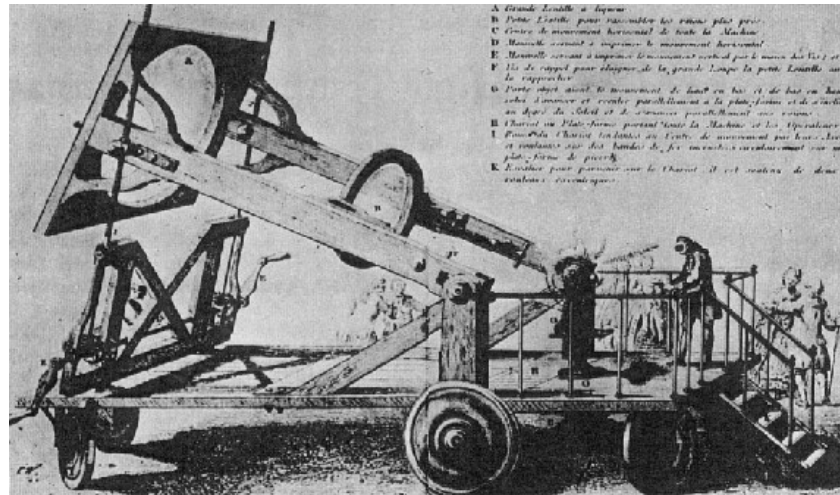


Figure 2. The first large solar furnace built in 1774 by the French Chemist L. Lavoisier. It was used to study the properties of metals by melting them by solar radiation in a very pure environment (Trombe 1955).

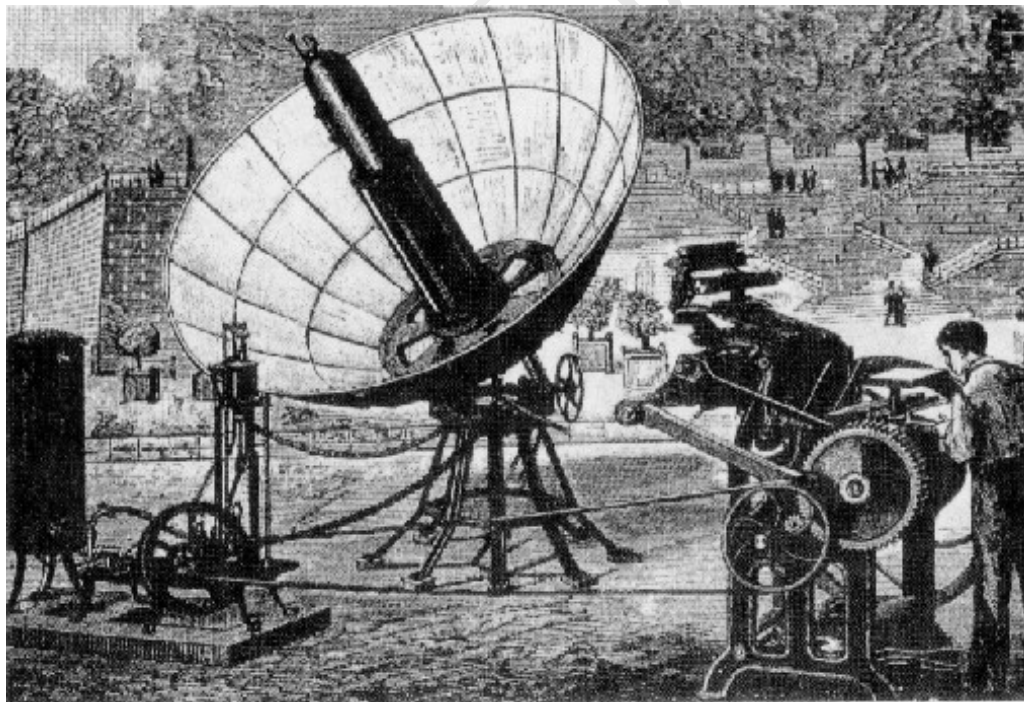


Figure 3. The Mouchot's solar power engine, as it was presented, in the 1778 Paris exhibition. The collected solar energy, in the solar concentrator drives a steam engine to operate a press. The press was used to print during the exhibition the "Sunshine Journal" (Teller 1979).

During the 19th century, a big interest in experimental work started, and resulted in the application of solar energy in various industrial fields. August Mouchot, French engineer, was one of the first pioneer scientists who worked on solar-mechanical power and thermal conversion devices. He built several steam driven solar power machines and also issued the first book on solar energy (1869, 1879). He published many articles on his experimental work about the industrial use of solar heat (1878, 1879, 1880), but he also invented one of the first boilers, to produce heat from solar radiation. He experimented on this boiler at several places in Algiers (1878). The solar machine which consisted of a conical reflector 20 m² total surface area, with a linear focus, was exhibited in the 1878 Paris Exposition. The collected solar energy was used to drive a printing press, and published in the "Sunshine Journal, " as shown in Figure 3, but the sketch of Figure 4 is in reproduction. The printing machine was powered by a two-thirds horsepower (~0.56 kW) solar steam engine. The parabolic mirror associated with the boiler was moved to track the sun.

In 1883 J. Ericson (1872) who during the US Civil War invented the Monitor, developed a solar-mechanical power system, a steam engine consisting of a cylindrical parabolic concentrator 4.80 m wide with an axis 3.30 m long. There exist no details about the construction and the operation of this solar machine. By the end of 19th century a second book on solar energy was published, also in French, by I. Royanmont (1882). At the end of the 19th century, in 1899, K. Armstrong presented his pyrheliometer, a device for the determination of direct (beam) solar radiation (Delyannis 1967).

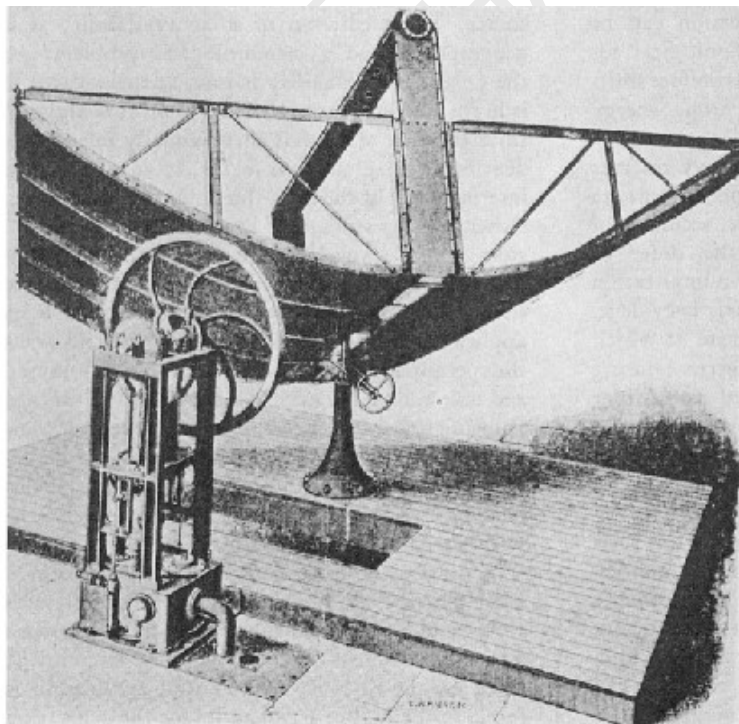


Figure 4. The concentrator used by Ericson, in 1883, to collect solar radiation for a mechanical power system (Jordan 1955).

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