Erasmus+

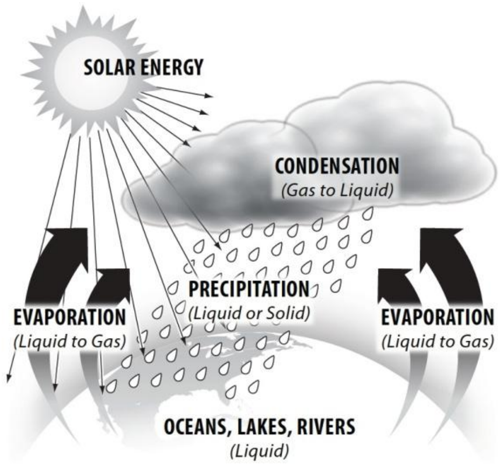
European Path (e)Motion – Senior High School of Thesprotiko

Work Sheet 3: *Hydroelectric Dams*

Name : …………………………………………………… Date: ……………………………………….

A. Useful Knowledge

What Is Hydropower?
Hydropower (from the Greek word *hydor*,meaning water) is energy that comes from the force of moving water. The fall and movement of water is part of a continuous natural cycle called the **water cycle**. Energy from the sun evaporates water in the Earth's oceans and rivers and draws it upward as water vapors. When the water vapor reaches the cooler air in the atmosphere, it condenses and forms clouds. The moisture eventually falls to the Earth as rain or snow, replenishing the water in the oceans and rivers. Gravity drives the moving water, transporting it from high ground to low ground. The force of moving water can be extremely powerful.



The water cycle.

Hydropower is called a **renewable** energy source because the water on Earth is continuously replenished by precipitation. As long as the water cycle continues, we won't run out of this energy source.

History of Hydropower
Hydropower has been used for centuries. The Greeks used water wheels to grind wheat into flour more than 2,000 years ago. In the early 1800s, American and European factories used the water wheel to power machines. The water wheel is a simple machine.
In the late 19th century, the force of falling water was used to generate electricity. The first hydroelectric power plant was built on the Fox River in Appleton, WI in 1882. In the following decades, many more hydroelectric plants were built.
By the late 1940s, the best sites for big dams had been developed. Inexpensive fossil fuel plants also entered the picture. At that time, plants burning coal or oil could make electricity more cheaply than hydro plants. Soon they began to under price the smaller hydroelectric plants. It wasn't until the oil shocks of the 1970s that people showed a renewed interest in hydropower.

B. Concepts

<u>*Hydropower*</u> :
How a Hydropower Plant Works
A typical hydropower plant is a system with three parts:

i. a power plant where the electricity is produced;
ii. a dam that can be opened or closed to control water flow; and
iii. a reservoir (artificial lake) where water can be stored.

To generate electricity, a dam opens its gates to allow water from the reservoir above to flow down through large tubes called **penstocks**. At the bottom of the penstocks, the fast-moving water spins the blades of turbines. The turbines are connected to generators to produce electricity. The electricity is then transported via huge transmission lines to a local utility company.

Head and Flow

The amount of electricity that can be generated at a hydro plant is determined by two factors: **head** and **flow**.

Head is how far the water drops. It is the distance from the highest level of the dammed water to the point where it goes through the power-producing turbine.

Flow is how much water moves through the system—the more water that moves through a system, the higher the flow. Generally, a high head plant needs less water flow than a low-head plant to produce the same amount of electricity.

Storing Energy

One of the biggest advantages of a hydropower plant is its ability to store energy. The water in a reservoir is, after all, stored energy. Water can be stored in a reservoir and released when needed for electricity production.

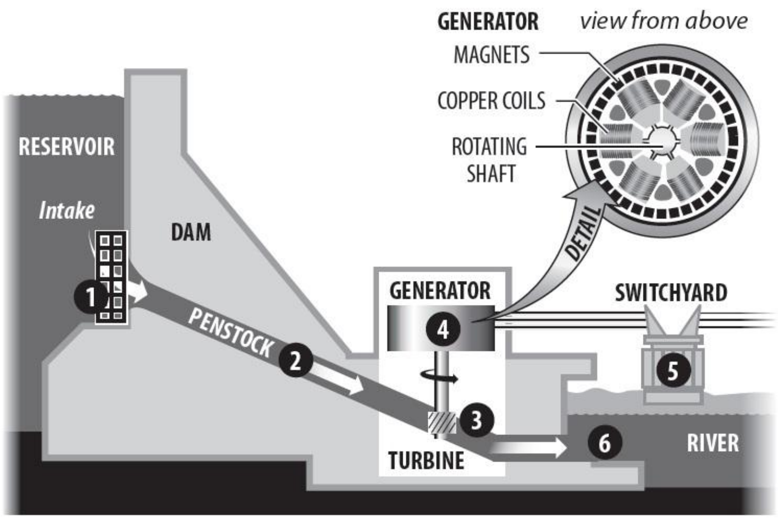
During the day when people use more electricity, water can flow through a plant to generate electricity. Then, during the night when people use less electricity, water can be held back in the reservoir.

Storage also makes it possible to save water from winter rains for generating power during the summer, or to save water from wet years for generating electricity during dry years.

Pumped Storage Systems

Some hydropower plants use pumped storage systems. A **pumped storage system** operates much like a public fountain does; the same water is used again and again. At a pumped storage hydropower plant, flowing water is used to make electricity and then stored in a lower pool. Depending on how much electricity is needed, the water may be pumped back to an upper pool. Pumping water to the upper pool requires electricity so hydro plants usually use pumped storage systems only when there is peak demand for electricity.

Pumped hydro is the most reliable energy storage system. Coal and nuclear power plants have no energy storage systems. They must turn to gas- and oil-fired generators when people demand lots of electricity. They also have no way to store any extra energy they might produce during normal generating periods.



1. Water in a reservoir behind a hydropower dam flows through an intake screen, which filters out large debris, but allows fish to pass through.
2. The water travels through a large pipe, called a penstock.
3. The force of the water spins a turbine at a low speed, allowing fish to pass through unharmed.
4. Inside the generator, the shaft spins coils of copper wire inside a ring of magnets. This creates an electric field, producing electricity.
5. Electricity is sent to a switchyard, where a transformer increases the voltage, allowing it to travel through the electric grid.
6. Water flows out of the penstock into the downstream river.

Hydropower Plant.

The conservation of energy : In nature, energy cannot be created or destroyed, but its form can change. In generating electricity, no new energy is created. Actually one form of energy is converted to another form.

To generate electricity, water must be in motion. This is kinetic (moving) energy. When flowing water turns blades in a turbine, the form is changed to mechanical (machine) energy. The turbine turns the generator rotor which then converts this mechanical energy into another energy form (electricity). Since water is the initial source of energy, we call this hydroelectric power or hydropower for short.

Electromagnetic induction: Electromagnetic or magnetic induction is the production of an electromotive force (i.e., voltage) across an electrical conductor in a changing magnetic field. Michael Faraday is generally credited with the discovery of induction in 1831

C. The Hydroelectric dam of Louros

It is located in river Louros about 50Km northwest of its discharge into Amvrakikos gulf in Epirus. It uses the waters of the river that come from the springs of Terovo and Saint George. The basin of flow of tank has extend of 319Km^2. The construction includes a concrete gravity arch dam of total volume 12000m^3 and maximum height 22m. The reservoir capacity is very small, 370000m^3.

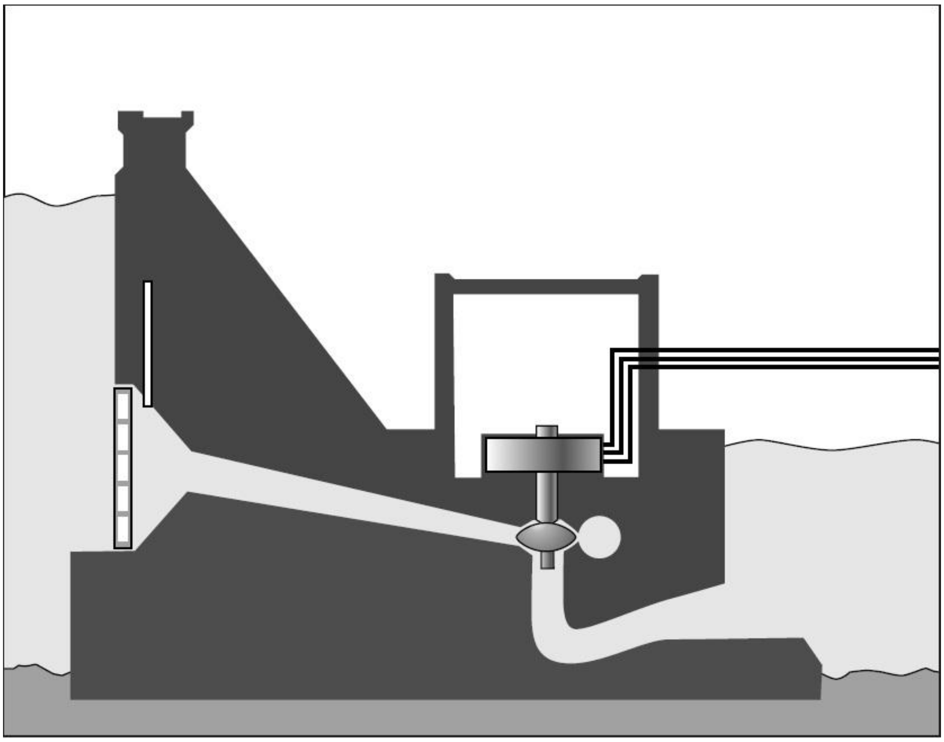
The hydroelectric dam of Louros

In 1954 the dam was equipped with two generators 2,5MW each. In 1964 the power of the plant increased with the addition of a 5,3MW generator reaching thus 10,3MW in total. All the turbines are Francis type of horizontal axis with average annual production 50GWH.

D. Working with dams

- Copy the labels below to the correct places on the diagram of the hydro electric power station:

  Reservoir – Gate – Intake – Long distance power lines – Powerhouse – Turbine – Generator – River



- Complete the gaps in the following passage using the words in the box.

stored	increases	generated	inefficient	more	electricity
hydroelectric	little	pump	gas	predict	dam
turbines	wildlife	night	unexpected	gravitational	

Electricity cannot be ________ so it has to be ___________ at the same rate as it is being used. If demand for electricity __________, power stations need to produce more electricity or __________ power stations need to come online to generate power. It is relatively easy to burn more oil, ____ or coal to increase power output. It is not so easy to change the power output of nuclear power stations.

People running the national grid need to ________ when people are likely to want electricity so that there is never too much or too ______ electricity. If there are sudden, _____________ changes in demand, hydroelectric power stations are useful.

At times of the day when power stations are generating more _____________ than is required (e.g. the middle of the _______), electricity in the national grid can be used to _________ water from a reservoir up into a raised ______ to give it ______________ potential energy.The water can be _________ in the dam until there is a sudden need for electricity. When this happens, the water in the dam can be allowed to fall through ___________, which turn generators to generate electricity.

A _______________ dam generates electricity without causing pollution. But building dams and flooding valleys to create reservoirs can affect the local ________________ and there are very few places in the world where a HEP can be built. The system is also a very _____________ use of electricity so it is only used when necessary.

- Place a tick in the appropriate column if the statement at the top of the column is true for that resource.

Renewable resource	Reliable	Expensive to set up	Can damage habitat or wildlife	Puts CO_2 into the atmosphere	Could cause chemical pollution	Only for specific sites
Hydro-electric power (HEP)						
Tidal energy						
Wave						
Wind						
Geothermal energy						
Solar panels (hot water)						
Solar cells (electricity)						
Bio-fuels						
Biomass						

- Write down the advantages and disadvantages of renewable (Hydroelectric Power) and non – renewable (Coal) energy resources into the table below.

Energy resource	Advantages	Disadvantages
Hydroelectric Power (renewable)		
Coal (non – renewable)		