*ISTITUTO TECNICO TECNOLOGICO*

*"FRANCESCO SEVERI"*

**SUN, WIND AND HYDRO**

# THE FUTURE OF MANKIND

**COMENIUS MULTILATERAL PARTNERSHIP**

**2009-1-CY1-COM06-00467**

Education and Culture DG

Lifelong Learning Programme

**Class 5 TC**

**School Year 2010/2011**

## Acknowledgement

Interdependence is a higher value than independence.

This virtual book is a synergistic product of many minds,
those of the students of the class 5TC
and of some teachers of this class.

The English version of this virtual book has been reviewed by
the English teacher of the class,

Damiana De Pascalis.

The sources we have referred to for this book are:

- brochures, CDs, leaflets and other material that was given to us during our tours of the various power plants;
- Web sites: Wikipedia.org, 01net.it and Venessia.com

# INDEX

# 1. INFORMATION

## 1.1. General Information

**•Project Title:**

**SUN, WIND AND HYDRO: THE FUTURE OF MANKIND**

- **Participating countries: Cyprus, Portugal, Italy, Poland and Greece**
- **Italian team coordinator: Dr. Ercole Mitrotta**

## 1.2. Project activity and accomplishments

The main objective has been to devise strategies to save energy and to develop renewable energy sources.
Students have been involved in the development of a tracking system for a photovoltaic panel and in the design of a circuit responsible for controlling the charge of the battery. In addition to demonstrating their technical abilities, the students will also have to determine if the increased amount of energy produced through the use of this tracking mechanism is worth the additional effort and production costs.
The students have also participated in a project aimed at measuring the degree of energy loss from the school building. The final intent was to develop more efficient ways to reduce energy loss through conservative energy management and through better thermal isolation methods.

## 1.3. Meeting Schedule

- **Initial project meeting in Padova from October 29th to the 1st of November 2009**
  Main events held in Padova:
  - Discussion at the RFX consorzio about the new perspectives regarding the production of environmentally friendly energy sources with particular reference to nuclear fusion.
  - Meeting in Venice to discuss the Greenhouse effect and its consequences on the sea level and to also explore the M.O.S.E project designed to preserve the Venetian lagoon.
- **Meeting at Karditsa (Greece) from the 22nd to the 26th of April 2010**
  **Faculty: Prof. G. Tombola**
  **Students: Contiero – Pinton**
  Main events held at Karditsa
  - Tour of the natural reserve and of the hydroelectric station at Plasteiras Lake
- **Meeting at Gorlice (Poland) from the 29th of September to the 3rd of October 2010**
  **Faculty: Prof. E. Mitrotta – Prof. G.Tombola**
  **Students: Artuso – Burattin**
  Main events held at Gorlice
  - Tour of the hydroelectric power station of Niedzika
  - Tour of the geothermal power plant at Podhalańsca
  - Tour of the salt mining facility at Wieliczka

- **Meeting at Viseu (Portugal) from the 23th to the 27 of March 2011-04-02**
  **Faculty: Prof. E.Mitrotta – Prof. G.Tombola – Prof. D.De Pascalis**
  **Students: Bilato – Filira – Semenzato**

  Main events held at Viseu
  - Meeting with local authorities
  - Tour of Caramulo wind farm
  - Tour of the car museum in Caramulo

One additional meeting (Cyprus), will be held from May the 4th to the 8th 2011 and will involve at least 7 participants.

# 2. ENERGY

## 2.1. *Energy saving*

### What is energy saving?

In a strict sense, saving energy means conserving energy that would be otherwise used and therefore, in practice, it means saving oil, natural gas, solid and fissionable materials. Energy is saved because most of the renewable energy sources cannot be saved; i.e., you can't save the incident solar energy that strikes the earth or the blowing wind in their natural state.
Energy conservation therefore means reducing the consumption of energy required for our needs and our pastimes. This may be achieved by changing our habits, by reducing waste production and by improving the efficiency of the technology that transforms and conserves energy. This increased efficiency will in turn reduce fossil fuel consumption which will help to protect our environment and reduce world pollution.

### How to save energy?

There are several ways to save energy and this process may begin by paying attention to our daily activities.
The most common way to save energy is to use less energy in our daily lives. This can be achieved through intelligent and considerate behaviour, such as turning off the lights when not in use, by reducing the use of stand-by appliances, by the use of low capacity vehicles and bicycles or even by walking. These methods produce small but important contributions without limits to the potential for energy savings; this relates, however, more to individual sensitivity, ethics and intelligence.
Energy saving reflects then our daily behaviour and is best described as "intelligent" insofar as it derives from knowledge and cultural habits.
There are two ways of **saving energy**: ***active*** and ***passive***

One common example involves replacing incandescent bulbs with fluorescent ones that emit a light that is several times greater than the amount of energy consumed. The heating system of buildings is another area where simple energy saving measures can take place. Here, the use of thermostatic valves and programmable thermostats, the replacement of old inefficient fixtures or of old boilers with condensing boilers and adding insulation to walls can save energy. All of these solutions can lower the consumption of fuel (passive saving).
Investing in the production and installation of heating systems or in the generation of electricity (active saving) is another example of energy saving which leads to a reduction in fuel consumption. Beginning today to produce energy autonomously, will translate into immediate savings and in the future, once the initial costs have been absorbed, it may represent an opportunity to earn money because we could sell the energy produced.
The **alternative energy sources** (sun, wind, sea and warmth from the earth) are available with today's technology and are also inexhaustible and thus will be used by future generations.

## 2.2. *Useful tips to save energy in small everyday actions*

**Electric boiler**

- Adjust your water heater to no more than 50°C (if the water is too hot, you will only have to add cold water, thus overheating water is a waste of energy).
- Do not keep it lit all day.
- Install the water heater near the point of use (to prevent heat loss along the hot water pipes).
- Install flow reducers on normal faucets: you can reduce water and energy consumption.
- Perform regular maintenance.

**Fridge / Freezer**

- The temperature should not exceed 5-7°C.
- Place the refrigerator in a well ventilated area, away from heat sources, such as the oven.
- Defrost the freezer regularly (the frost layer acts as an insulator by increasing the energy consumption).
- Replace the seals of the unit if they are worn.
- Regularly remove any dust that has deposited on the coils of the fridge \ freezer (to allow for better heat exchange with the air).

**Lighting**

- Do not keep lights on unnecessarily.
- Replace old light bulbs with energy-efficient ones.
- Clean lighting fixtures regularly (dust significantly reduces light output).

**Television and other electronic equipments**

- Do not keep electronic equipments in the standby mode.
- Enable the “saving mode” on computers.
- For periods exceeding 10 minutes, turn off the PC monitor: it is untrue that repeatedly turning your computer on / off will damage it.
- At night, always turn off the computer and printer by pulling the plug: the processors continue to consume electricity even when the PC is off.

**Washing Machine**

- Use the washing machine with a full load (or use the half load button).
- Wash at low temperatures (current detergents are already active at low temperatures and washing at 90 ° C deteriorates faster the laundry; in a wash cycle, you consume more energy when the water is heating).
- Use scaling products (to facilitate the action of detergents and allow the coil to heat water and to operate effectively).
- Avoid using the drying scrubber (the electricity consumed during the drying cycle is equal to that used in the washing step).
- Use the washing machine at night.

**Dishwasher**

- Use the full load.
- Clean the dishes from food which may clog the filter and reduce washing efficiency.
- Wash at low temperatures.
- Avoid, if possible, the drying cycle: it involves the expenditure of a lot of energy.
- Use a scaling product.
- Unplug the electrical connections and close the valves of the water supply before a long period of inactivity.

**Conditioners**

- Adjust the thermostat, making sure that the difference in temperature between the exterior and the interior does not exceed 5°C.
- You can use other means to avoid overheating the rooms in summer, such as ventilating the premises at night and restricting the access of external air during the hot afternoon hours, protecting the area from direct sunlight by using curtains, blinds, tinted glass and painting the outside of the house with light colours or creating shade through the use of shrubs and trees.

**Energy saving** is a goal, while the use of energy, with the application of efficient technologies and a good dose of common sense, is the means for reaching the goal.

## 2.3. *Italian Legislation on Renewable Energy*

At the national and regional levels a wide range of economic and regulatory incentives is now available in order to promote the use of renewable energy and energy efficiency, by both businesses and citizens. Here we omit the various incentives at the regional level, which are also numerous and significant, to focus on those established at the national level.
With regards to the rules on renewable energy, we must remember:

- **Green Certificates**
- The **all-inclusive price**
- The **Retreat**
- The **on the spot exchange**
- The **Energy Bill**

Let us examine them one by one.

### Green Certificates

The Italian legislation on renewable energy, especially on Green Certificates (GC) is somewhat complex. The starting point is the Legislative Decree 79/99, also known as the Bersani Decree, which implements the European Directive 96/92/EC on "common standards for the internal electricity market." The decree stipulates the liberalization of energy markets and introduces new forms of incentives for renewable energy. It further obligates producers and importers of electricity to utilize renewable sources.
The mechanism of GC then underwent a substantial change with the approval of the Finance Act of 2008.

### The all-inclusive price

A second incentive mechanism, introduced by the Finance Act of 2008 and which is an alternative to the Green Certificates, is the so-called all-inclusive price.
The rate was established mainly to promote the development of small systems, greatly simplifying procedures and ensuring a fixed and predictable return. It is granted for a period of 15 years, and covers all renewable sources, with the exception of photovoltaic (PV) energy whose incentive mechanisms are outlined in the "Energy Bill". After fifteen years, the electricity will be remunerated according to the economic provisions of Article 13, Decree 387/03, which is based on market conditions. The all-inclusive rate can be updated every three years.

## The Retreat

The retreat is a simplified form for the sale of electricity in force since January 1st, 2008. It represents, for producers of energy from renewable sources, a viable alternative of selling through bilateral contracts or by direct sale on the stock exchange.
It is often favoured by producers for two simple reasons:

- The ESM (Energy Service Manager) becomes the sole representative for the producer of energy who thus avoids having to deal with each company responsible for the delivery and distribution of the energy;
- Under the Retreat plan, the contract between the energy producer and the ESM substitutes all the other bureaucratic requirements thus simplifying the process.

## The "on the spot" exchange

The Exchange is a service provided by the ESM and has been in force since January 1st, 2009.
It allows the official energy producer to receive compensation for the amount of electrical energy produced and conveyed to the power grid. Compensation is restituted at a time different from that of production and it takes into account the value of the energy at the time of production. In short, it may be considered as a way to accumulate energy credits for later use.
In 2008, new modifications were introduced. These changes in fact render the process applicable also to power plants

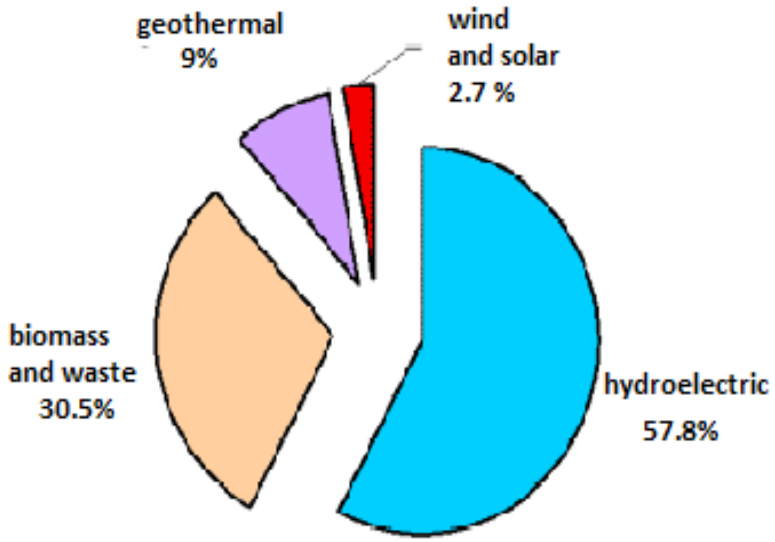
- using renewable sources up to 20 kW;
- using renewable sources up to 200 kW (only if in service after December 31st, 2007);
- cogeneration of power up to 200 kW

## Energy Bill (photovoltaic)

It is necessary to clarify that the tariffs provided by this bill can only be applied to photovoltaic systems which cannot therefore make use of other incentive plans, such as certificates or the all-inclusive price.
The "Energy Bill" allows for the direct sale of the energy produced to the ESM, who in turn will pay an "incentive" for the PV energy. In other words, the Energy Bill directly encourages the production of electricity rather than promoting the initial investment. According to this mechanism, the owner of the PV system, in exchange for the energy sold, receives money for the first 20 years of the investment.
The energy bill first came into being with the Ministerial Decree of July 28th, 2005 but was subsequently amended by the Ministerial Decree of February 19th, 2007, entitled "Criteria for the promotion of electricity generated by photovoltaic conversion of solar energy".

## *2.4. Distribution of Renewable Energy in Italy*

### a) Hydroelectric Energy




| Advantages | Disadvantages |
|---|---|
| Low costs<br>It doesn't need raw materials<br>Easy to manage | Requires vast areas<br>Sedimentation |

## Distribution

| Region | Province |
|---|---|
| Campania: | Salerno |
| Emilia Romagna: | Piacenza, Cesena |
| Friuli Venezia Giulia: | Udine, Pordenone |
| Lazio: | Viterbo |
| Lombardia: | Milano, Bergamo, Sondrio, Brescia, Biella |
| Piemonte: | Torino, Cuneo, Varese |
| Toscana: | Lucca, Massa, Carrara |
| Trentino: | Bolzano |
| Umbria: | Terni |
| Val D'Aosta: | Aosta |
| Veneto: | Padova, Vicenza |

## b) Eolic Energy

| Advantages | Disadvantages |
|---|---|
| Clean Energy | Low return |
| Low costs | Limited areas to build stations |

## Distribution

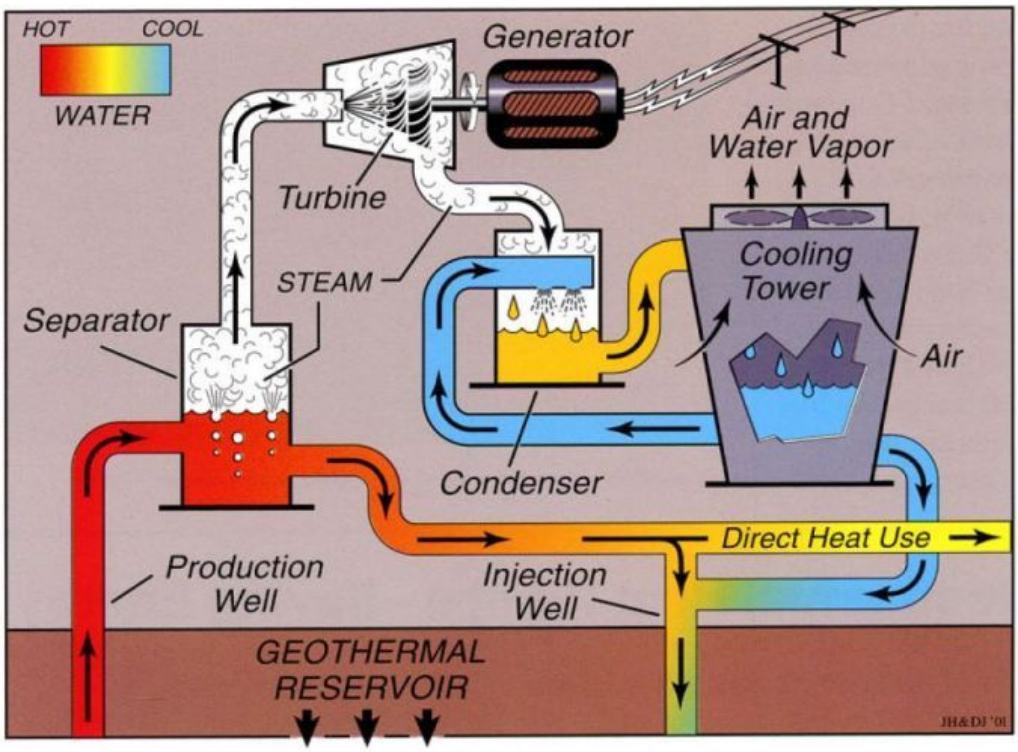
| Region | Province |
|---|---|
| Abruzzo: | Aquila |
| Basilicata: | Potenza, Matera |
| Calabria: | Cesena, Catanzaro |
| Campania: | Avellino, Salerno, Cesena, Benevento |
| Emilia: | Romagna, Bologna |
| Molise: | Campobasso, Isernia |
| Puglia: | Foggia, Lecce |
| Sardegna: | Sassari, Cagliari, Ogliastra |
| Toscana: | Pisa, Grosseto |

## c) Geothermal Energy

| Advantages | Disadvantages |
|---|---|
| Clean Energy | Low return |
| High availability | Limited areas to build plants |
| | Risk of geothermal eruption |
| | Pollution |

## Distribution

| Region | Province |
|---|---|
| Toscana: | Pisa, Siena, Grosseto |

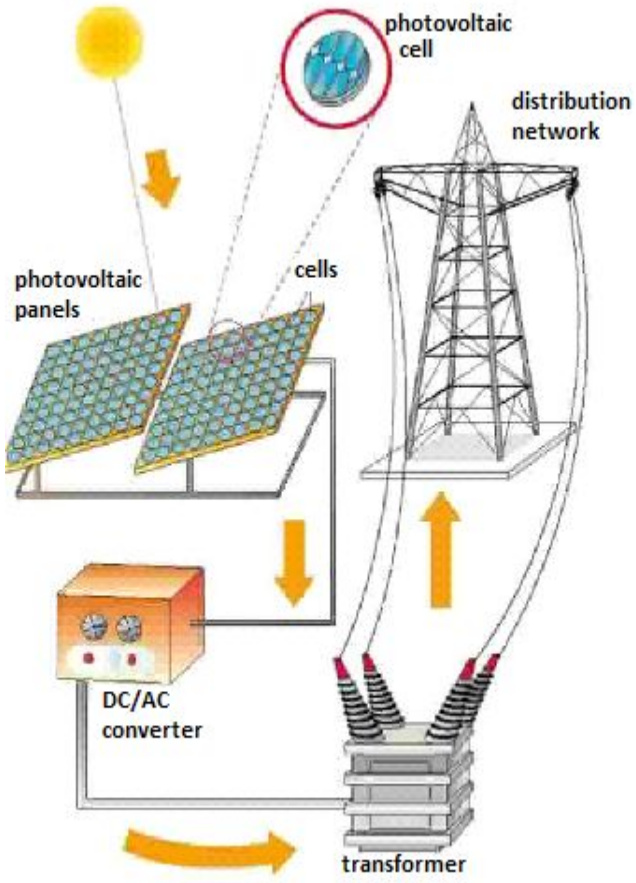


# d) Solar Energy

| Advantages | Disadvantages |
|---|---|
| Clean Energy | Difficult distribution |
| Limited Emission | Dependency on the Sun |
| Free exploitation | Requires vast areas |
| Simple production process | |

## Distribution

| Region | Province |
|---|---|
| Sicilia: | Siracusa |

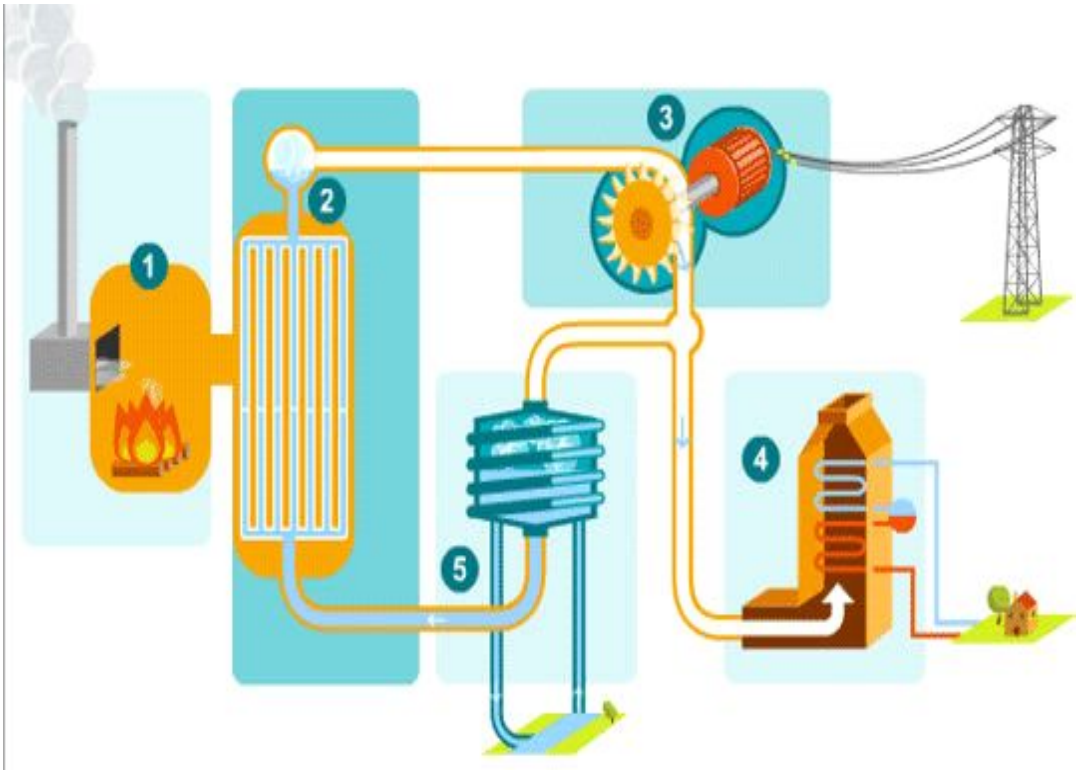


# e) Energy by Biomass

| Advantages | Disadvantages |
|---|---|
| Reduces the greenhouse effect | Pollution |
| Funded by ecologists | Not available year around |

## Distribution

| Region | Province |
|---|---|
| Calabria: | Crotone |
| Lombardia: | Milano, Varese |
| Puglia: | Bari, Taranto, Manfredonia |

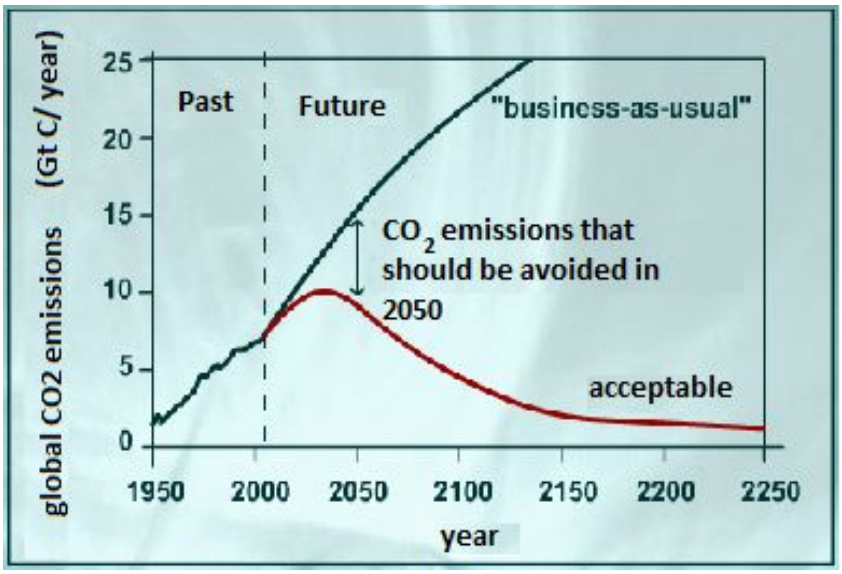


## 2.5. *Our World's Energy*

### We must continue to develop alternative energy sources

**•We need CO2-free energy sources**

The rise of the $CO_2$ concentration in the atmosphere threatens our climate. To reverse this trend, we need energy sources that don't emit $CO_2$, as for example biomass, solar, wind, fission and fusion. Another option is to catch the $CO_2$ formed by fossil fuels, and store it underground.
Scientists say that we need to reduce our emissions by at least 60-70% in the next fifty years, if we are to remain within acceptable limits. And after that period, the $CO_2$ release will have to be further reduced.




***Global $CO_2$ emissions***

The curve indicates that an "acceptable" $CO_2$ concentration is equal to 550 ppm, double what it was before the industrial revolution.

**•Renewable energy sources are a part of the solution**

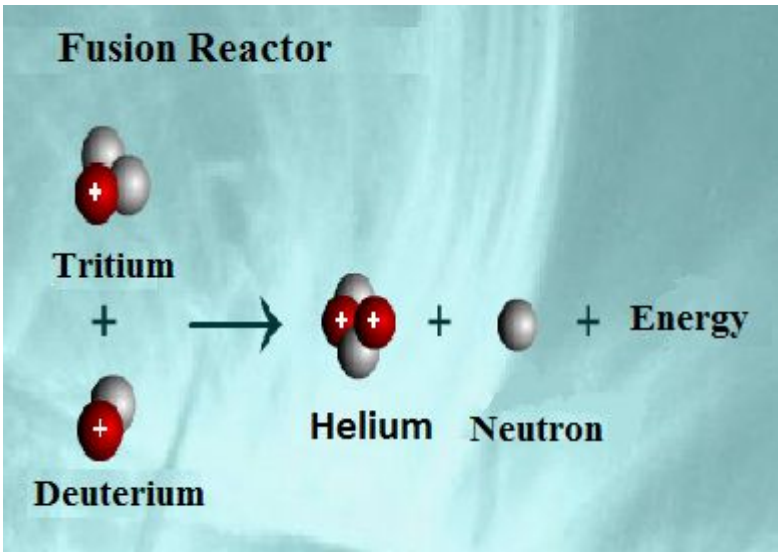
Renewable energy sources like biomass, solar, geothermal and wind energy have experienced a rapid development during the last years and have a great potential to contribute to a $CO_2$-free energy production system.
Hydroelectric power is the largest renewable source: it furnishes over 17% of the world's electricity. The rest of the above named sources currently contribute about 1% to the world energy demand.
Most of the suitable locations for hydroelectric power have already been exploited, so the growth of renewable sources will have to come mainly from solar, wind and biomass.

**•Fusion, the power source of the Sun**

Fusion is the process that powers the sun and the stars. It is the reaction in which two atomic nuclei combine or fuse to form a heavier atom. When light atoms, such as hydrogen, fuse a lot of energy is released. Fusion is the opposite of nuclear fission, where heavy atoms are split into smaller pieces.
Fusion offers a safe and environmentally responsible energy source. Scientists and engineers all over the world are working together to learn how to use nuclear fusion on the earth. If successful, fusion energy can help fulfill the world's energy needs in a more sustainable way.

## •The fusion process

In the fusion process, two light atoms fuse together to make a larger one. During this process, a lot of energy is released from the strong forces acting in the nucleus.
In the picture, a deuterium nucleus (an isotope of hydrogen) fuses together with a tritium nucleus (another isotope of hydrogen) to form a helium nucleus, and a single neutron.

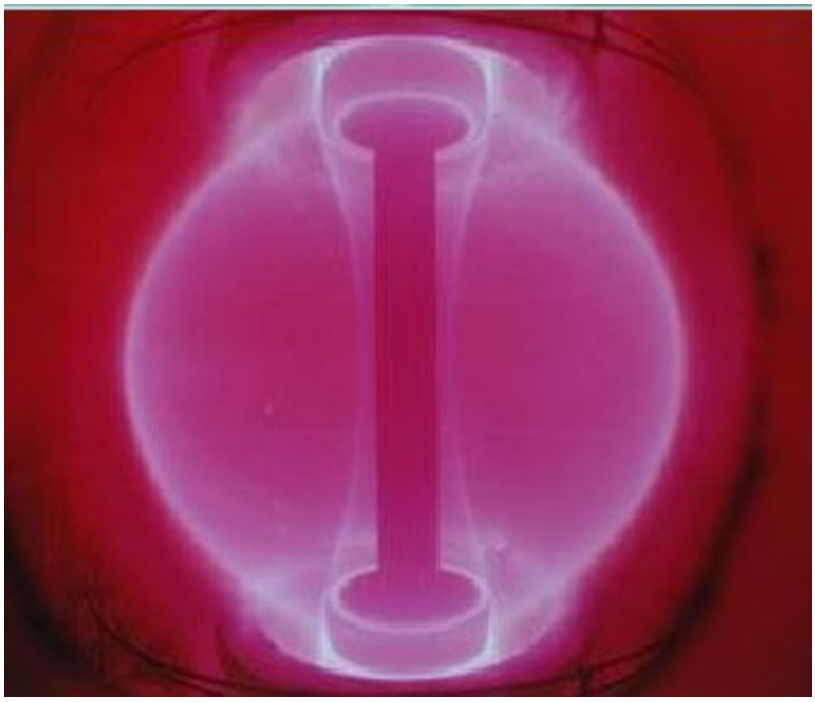



## •Deuterium and tritium

Deuterium and tritium are isotopes of hydrogen. This means that they differ from hydrogen only in the amount of neutrons in their nuclei. Deuterium has one extra neutron and tritium has two.
Each litre of ordinary water contains about 33 milligrams of deuterium which, if fused with tritium, is equivalent to approximately 340 litres of petrol. There is enough deuterium in the world's water to provide energy for billions of years.

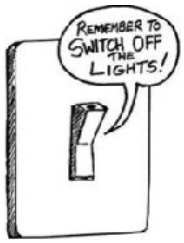
## ○ Fusion doesn't produce greenhouse gases

The only gas produced by fusion is helium. This is a harmless and inert gas already present in the earth's atmosphere. A 1000 MW fusion power plant would only produce about 250 kilograms of helium each year, whereas a comparable coal-fired power plant produces about 7 million tons of carbon dioxide every year. The operation of a fusion power plant doesn't produce greenhouse gases.



## *2.6. Energy Saving Suggestions*

1) **Turn off** the light when you leave the room or when there is enough sunlight




2) **Turn off** the laboratories electronic devices when not in use.
Remember that devices on standby consume electricity

3) **Turn off** the heating systems when the windows are open. Remember to air-out the rooms every hour

4) **Make sure that all faucets are closed;** don't waste water

5) **Be sure** to properly separate your garbage by placing all items in the respective bins

6) Waste paper should be placed in the proper collection boxes located in the various labs and classrooms

7) Keep all classrooms and common places clean in order to **reduce** the use of detergents and other chemical products

8) The use of bottled and singly prepackaged items, will only increase the amount of waste produced. When possible containers and packaging should be reused.

9) Avoid waste of material in the laboratory.

10) Report any fraud, waste or abuse to the proper authorities in order to improve the school environment

The earth also belongs to you. Please, help to preserve it by reducing waste production and pollution and remember the best way to save energy is not to waste it!

Scuola Amica del Clima

ECO-GENERATION

# 3. ALTERNATIVE ENERGY SOURCES

## 3.1. *Poland: Geothermal Power Station*

A geothermal power station is a special type of power plant which either transforms the energy from underground water and steam pressure into electrical energy or directly uses it to heat homes near the power station.
When we were in Poland, we saw this type of power station and here you can see some pictures of it.

In the pictures below you can see some external parts of the geothermal power plant:

These pictures illustrate an external steel structure which also allows us, by means of a manometer, to measure the pressure of the underground water and steam. When a technician opened a valve, we could visualize the power due to the pressure and we could feel the high temperature of the water. The water temperature reached a maximum of 80°C at a pressure of 3 atmospheres; you can imagine the power that this energy source is able to generate.

In the picture on the left, the technician is illustrating just how the water flows underground.

He explained that it actually flows in small channels-capillaries which have been created by the erosive action of the water under pressure in the rock bed.

The image on the right illustrates a piece of underground rock and the capillary channels which are so small as to be seen with difficulty (also because the picture definition is not the best).

These three pictures illustrate the internal parts of the power plant where the steam is conveyed thus heating the surroundings. The temperature inside the plant was significantly warmer than that of the outside but since it was contained in the conduits, it was a dry type of heat.

## *3.2. Poland: Hydroelectric Power Plants*

# Czorsztyn – Niedzica - Sromowce Wyżne

Czorsztyn - Niedzica - Sromowce Wyżne (Fig. 1) is a complex of two hydroelectric power stations located in northern Poland near the border with Slovakia. They are designed to optimize the production of electricity at different times of the day.

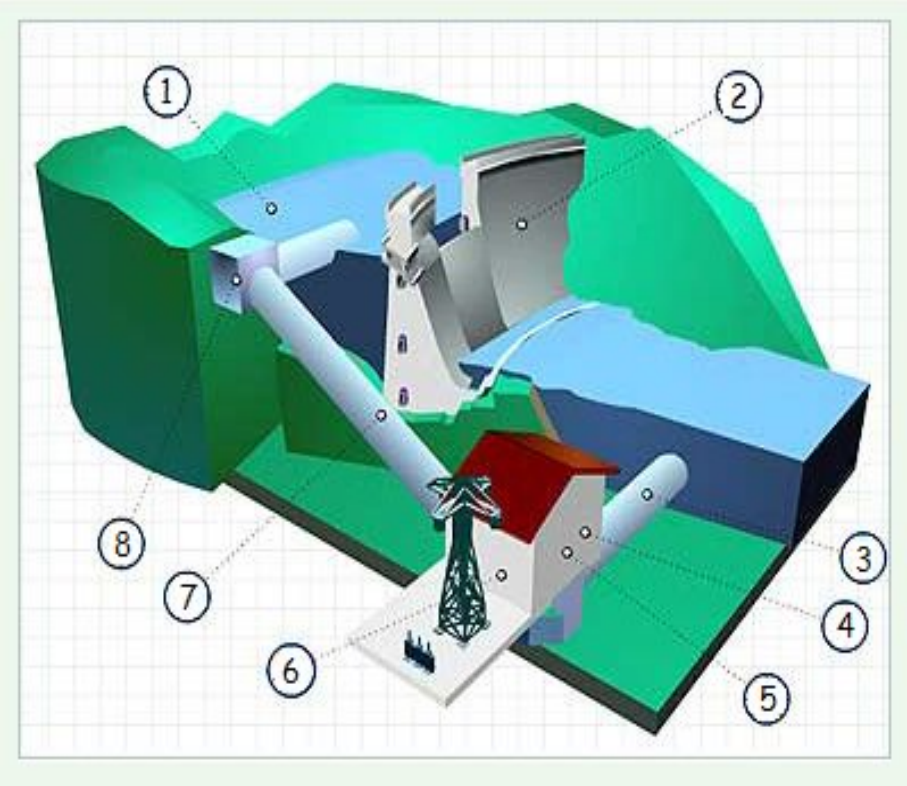
The group consists of two units: the first dam is Czorsztyn (Fig. 2) with two turbines each capable of producing 46MWh (the energy necessary to meet the needs of more than 15,000 households). This energy is supplied by a lake almost 8km long and 1km wide. The second dam is Sromowce Wyżne (Fig. 3) that produces 2MWh with its four turbines.

*Fig. 1*

The hydroelectric plant harnesses the energy of falling water and uses mechanics to convert that energy into electricity. During the process,

*Fig. 2*

1. a dam interrupts a stream of water, thereby creating a reservoir;
2. the water is conveyed through channels and tunnels called penstocks and is brought into a control gate, which regulates the quantity of water flowing through the turbines, according to the demand for energy;
3. the water spins the turbines and then flows out into the lower lake;
4. the turbine is directly connected with the generator, which transforms the mechanical energy (received from the turbine) into electrical energy;
5. the transformer steps up the voltage that is produced by the generator, and sends power to the grid.




***Caption***
*1. Reservoir*
*2. Dam*
*3. Outflow*
*4. Turbine*
*5. Generator*
*6. Transformer*
*7. Penstock*
*8. Control gate*

*Fig. 3*

This group of power plants operates in a particular way. During the day, especially at the times of the greatest need for energy, all six turbines are activated (two of the Czorsztyn and four of the Sromowce Wyżne) for a total production of 94MWh; at night, on holidays or when there is a lesser demand for energy, the Czorsztyn turbines reverse their rotation to draw water from the reservoir below the dam and refill the upper lake, in order to accumulate a greater reserve of water to use during the day.

## *3.3. Portugal: Caramulo wind farm*

The Caramulo wind farm, in Portugal, is composed of 45 turbines for generating energy. The wind moves the blades which are connected to an AC generator in the turbine thereby producing an electric current. The frequency of the current depends on the speed of the rotation that is not, however, constant. The energy produced by the turbines is therefore converted to DC current and then reconverted to AC current with a frequency of 50Hz which is suitable for use in the power grid.


The total productive capacity in the Caramulo wind farm is approximately 90 MW. Every year this complex generates 175 GWh of energy from the power of the wind. A wind tower is 64 meters high with a blade 34 meters long and a sweep area of 3900 $m^2$. Each tower produces 4,200,000 Kwh per year. The Caramulo project also includes a power station, roads connecting the various wind towers, and power lines carrying the electrical energy from the towers to the power station and ultimately to the power grid.

The benefits of this project are:

1. A regional economic "windfall" of 15,5 million euro
2. Municipal road improvement
3. Fire protection support to the area
4. Positive environmental impact
5. Rehabilitation of public heritage
6. Preservation of local archeological heritage
7. Environmental monitoring action

However, the wind farm creates some problems: it spoils the view and it is dangerous for animals, especially for the birds.

# 4. SOLAR PANEL PROJECT

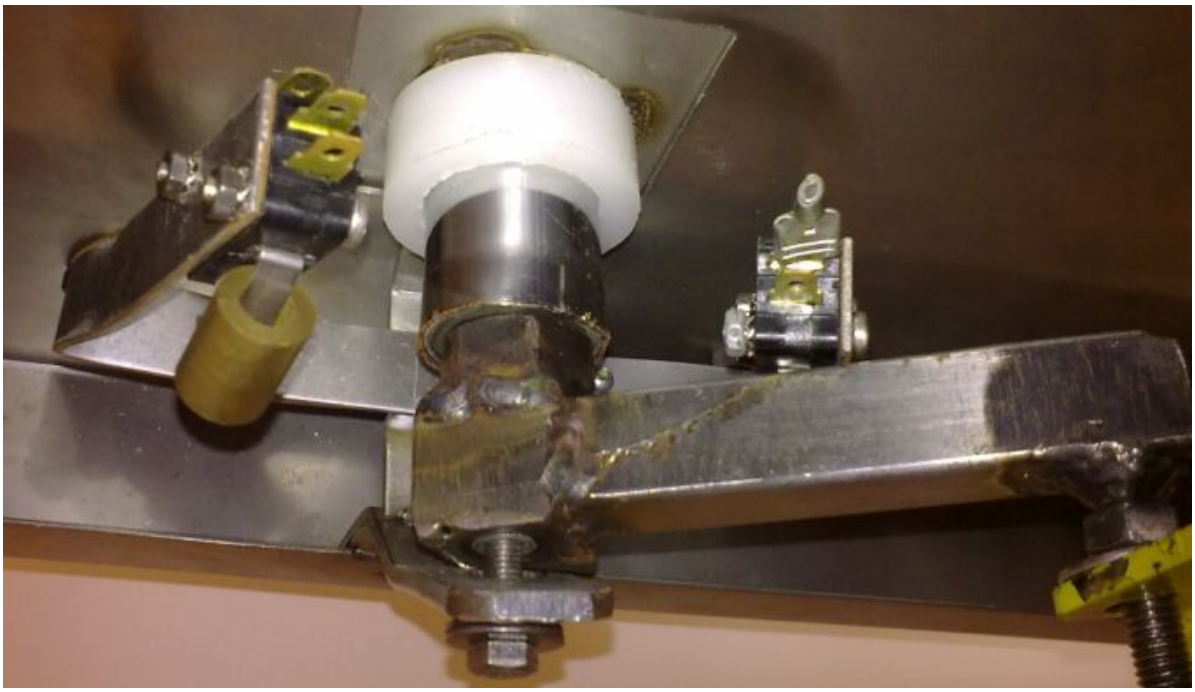
## *4.1. Solar panel mechanic parts*

For the Comenius project, we wanted to develop a machine that would follow the sun.

The movement duration is of ten hours a day. In the morning the solar panel is oriented towards the sun at an angle of 30°. At the end of the day, when there isn't enough light to charge the batteries, the panel will rotate 180° and return to the starting position.
In addition to the electronic elements, there is also a mechanical component, which consists of two electric motors: one for motion along the vertical axis and one for motion along the horizontal axis.
To understand how these motors can move this small solar panel, we can use the example of terrestrial coordinates: placing the panel on a fixed point on the earth, the motors are designed to track the sun both with respect to the latitude and the longitude.

Our panel, when viewed from the sun, will appear to be in a fixed position.
The motors (12 V) work with a linear direct current (DC): this means that the current applied is directly proportional to the speed at which they work.
The overall mechanism was improved by the introduction of a second motor, which is small in size because the panel was accurately balanced by a series of weights, which reduce the effort required to orient the solar panel. Contributing to the efficiency were special hinges and terminals that were designed and manufactured in the mechanical laboratory of our school.

Another significant problem was constituted by the necessity to create a stable metal support while keeping in mind the need to produce a project that was mobile, that is, not excessively heavy.
The entire mechanism and the battery to be charged were placed in a large stainless, steel container, which, once closed, would be strong enough to protect the contents from the weather and other elements.



This was built in our laboratory: the main parts were welded while the electronic hardware and the motion sensors were fixed with nuts and bolts in order to be easily removed.

## *4.2. Overview and CPU board*

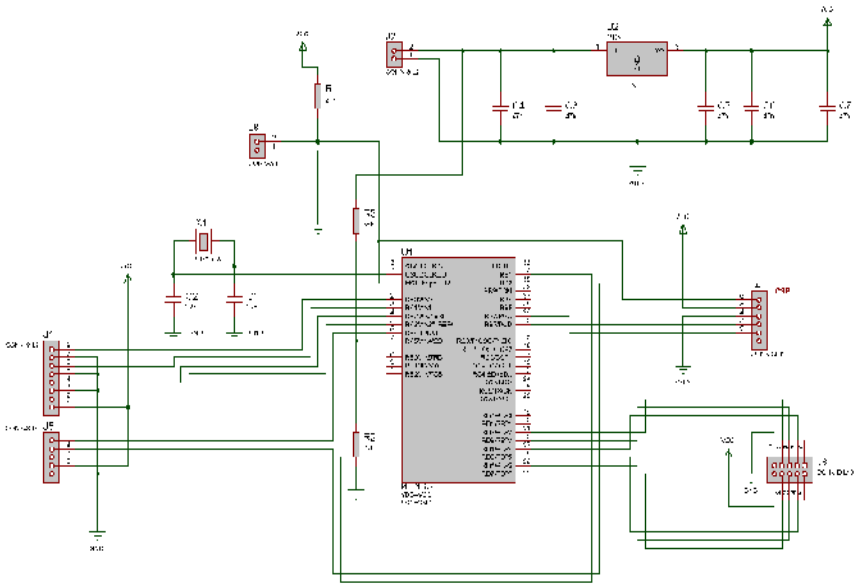
# The Project

Our project consists in building a photovoltaic system designed to obtain the maximum amount of energy from a photovoltaic panel. To do this we needed a structure that would support a photovoltaic panel and which is moved by two DC motors. In this project the system is controlled by a CPU board and 3 peripheral cards, which can be located far from the main board.
The CPU receives data such as relative brightness, panel and battery voltage, and sends commands which activate the two motors and turns on the battery charge.
It contains a Microchip® microcontroller PIC16F877:


This PIC has 8 channels to capture voltages and many other outputs and inputs used to control the other peripheral cards.
It is programmed in assembly language.
The figure below illustrates the general schematics, which includes all the connectors for the devices and the voltage regulators.

# Objective

The aim of this project was not to build a device that had been previously constructed and even in more complex ways.
This project has been prepared for possible future expansion. In fact, a more useful future application would involve the storage of information relative to the amount of current absorbed per minute and the transmission of these data (by cable or wireless) to a PC where a study on the difference in energy produced between a moving and a fixed panel could be evaluated. The status and the control of the device could also be conducted remotely.

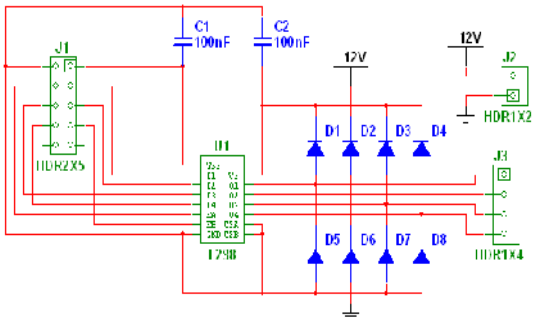


## *4.3. Project Description and Operation of the Electronic Devices' Peripheral Boards*

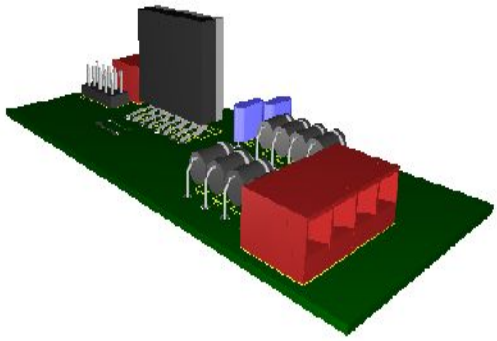
Our project has been designed to store as much electric energy as possible generated by a photovoltaic panel.
We have built a mechanical system based on two motorized axis, which are able to move the solar panel.
There are 3 external electric boards on the motherboard:
- the first is the circuit that drives the motors;
- the second is the circuit that controls the charge of the battery;
- the third is the circuit that detects the position of the sun.

# Motor Control Circuit

The "heart" of the circuit is the IC named L298N, which is designed to drive two mid power motors or a single more powerful motor.
The working principle of this IC is based on a "H Bridge".
This method is used when there is a need to drive a load (for example a motor) or when you need to invert the load's voltage. In the example of the motor, if you invert the voltage, the motor will turn in the opposite direction.



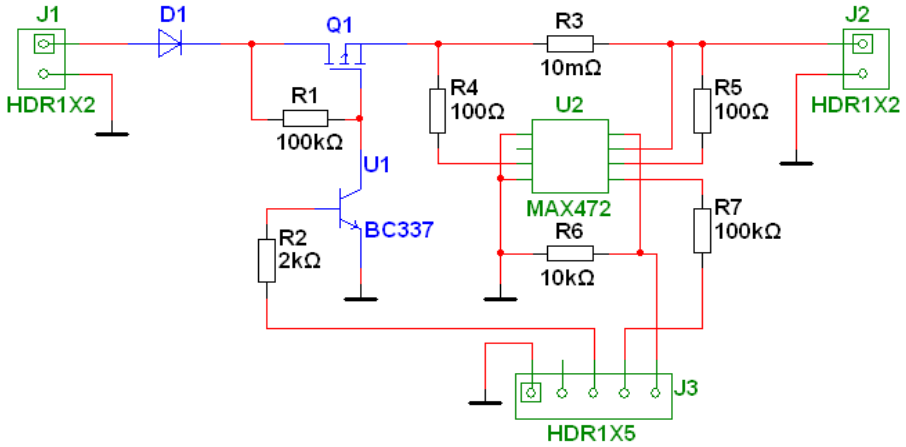

*«Wiring diagram of the motor control card»*



*«Three-dimensional display of the project board»*

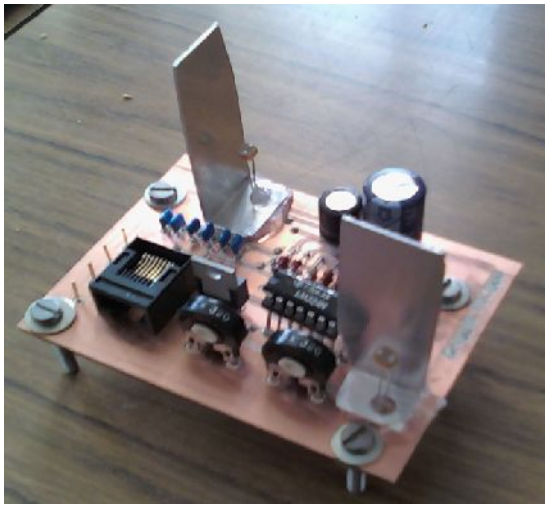
# Battery Charge Circuit

This board has two functions:
the first is to constantly control the current that charges the battery and sends an electric current to the main board, while the second function is to disconnect the photovoltaic panel from the circuit by means of an electronic switch or MOSFET. Accordingly the solar panel stops charging the battery when it is fully charged or when there is an error in the system

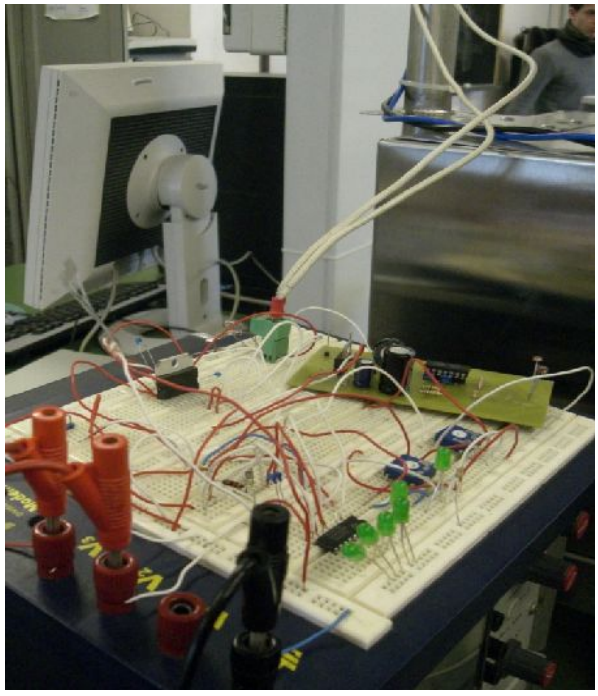



# Electronic Circuit for Detecting the Position of the Sun

This circuit is used to detect the sun's position by sending two distinct signals to the main board.
With these signals the main board can move the PV panel perpendicularly to the sun.
The circuit utilizes four light sensors (two for each axis) separated by an aluminium foil. These sensors detect the quantity of light on the different sides of the foil. In this manner the board can detect exactly which sensor is more illuminated.



***above:*** *photo of the electronic board of the circuit that detects the position of the sun;*



***on the right:*** *the breadboard used for testing this board*

# 5. OTHER PROJECTS AND ACTIVITIES

## *5.1. Parco "La Fenice"*

The Phoenix Park was opened in 2005 by Padua scouts and the Consorzio Zona Industriale of Padua. It is one of the first projects directed towards preserving the environment which represents a joint venture between the public administration and the private sector.

The area of the park measures 50.000 square meters. The project involves planting 250 different types of trees in an area of 15.000 square meters. Currently trees are being planted in another area of 20 square meters and a house is being rebuilt near the park. It will become an environmental learning centre.

In the park, biologists are attempting to introduce new plant species into environments that are normally hostile to them. These scientists are also concerned about reestablishing the local fauna, in particular the population of woodpeckers. They are also interested in studying the population of bees through monitoring their hives.

Experts are also testing new power sources, like solar energy, wind energy, hydroelectric energy and they want to employ new energy efficient systems, which involve:

- the use of low energy consumption light bulbs
- the use of special filters, which are installed on the water faucets to reduce water consumption
- the installation of thermal isolating materials to reduce heat loss from homes
- the production of hot and cold air with geothermal energy.

**All of these experimental methods are studied at the environmental learning centre.**

# The role of a bee in environmental monitoring

A bee is used as an indicator for biological pesticides, heavy metals (urban and industrial pollution) and for radioactive elements. In fact, this insect patrols an area of about 7 $km^2$ following the blooms and taking "samples" of nectar and pollen. It is able to readily perceive the changes taking place in frequented areas and communicate this to the other bees.

The number of dead bees in front of the hive and the absence of any lethal substance in their bodies or in hive products, provide signals that allow us to monitor the surrounding environment.
Combining together the data obtained from mortality rates and analytical findings, we are able to draw maps of environmental contamination by pesticides; this is extremely important because these chemicals also have adverse effects in humans and other species.

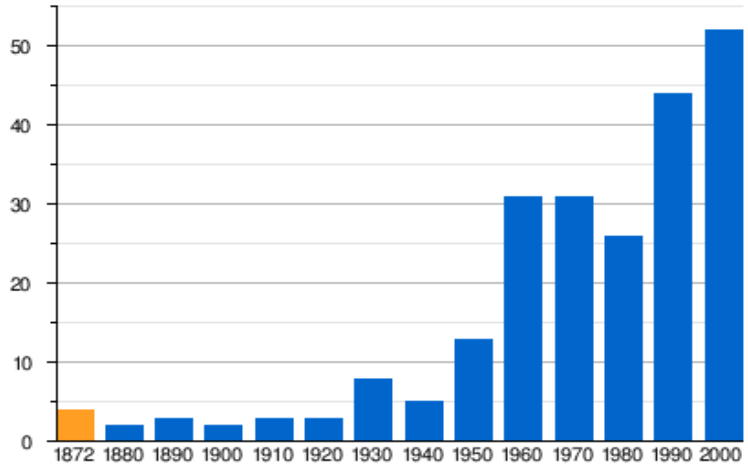
The practical application of the bee as a biological indicator is developed in four phases:

- The creation of two monitoring stations/hives fitted with cages for the collection of dead bees whose mortality threshold is set at 300 bees per week per station.
- The analysis in the laboratory.
- The analysis of the pollen on the bodies of bees in order to establish the crops frequented by bees.
- Collection of data on the toxicity and biological half life of the pesticides which are then correlated with the level of mortality recorded.

## 5.2. *The Mo.S.E. Venice*

Since ancient times the city of Venice, located in the Venetian lagoon, has had the problem of high water levels for most of the year. This natural phenomenon has particularly worsened during the last decades. Tides have always been a big problem. Each year, they submerge most of the city. This event attracts curious tourists but it causes a lot of inconvenience to the local economy and uncountable damages to the city.

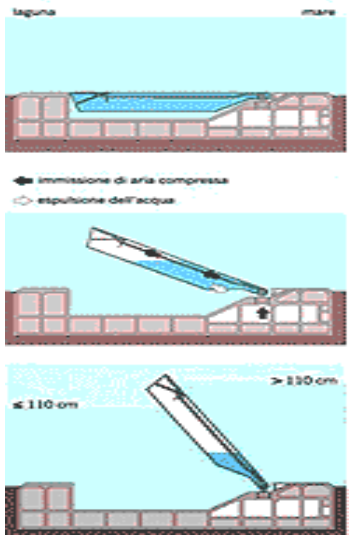
In the eighties, a team of experts studied a solution to avoid the high tides and so began the construction of the Mo.S.E. (Electromechanic Experimental Module) project, a major engineering work that is still under construction. Its purpose is to isolate the whole lagoon from the Adriatic Sea in the event of exceptionally high tides (from 110 cm up to a maximum of three meters).




There are three gates in the project, located in the three ports that allow communication between the sea and the lagoon: Lido, Chioggia and Malamocco.

These structures are rectangular and box-shaped.

They are made of bulkheads, which are similar to a metal box 20 meters wide, 20 to 30 meters long and 5 meters deep. Bulkhead motion is gravity controlled.



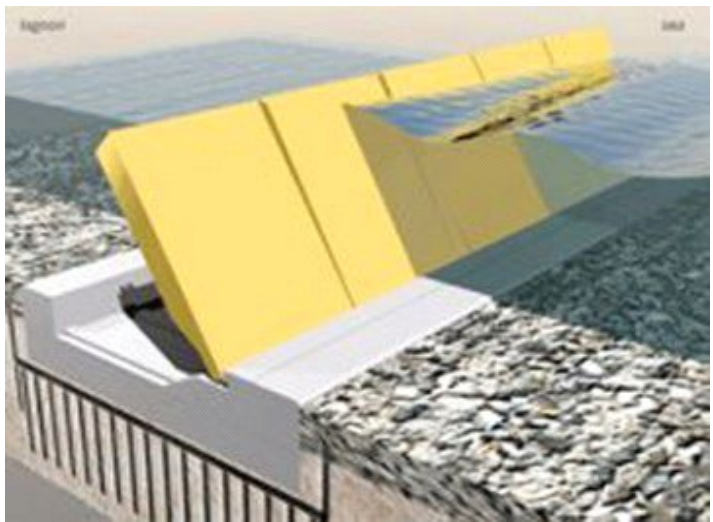

During normal conditions they are full of water and rest on the seabed in reinforced concrete blocks.

When high tides are expected (greater than 110cm) air is forced into the bulkheads, water is displaced and the bulkheads rise to the surface while pivoting on a shaft.

At this point the lagoon is isolated from the rest of the sea as the bulkheads stop the tidal flow. It takes approximately 30 minutes to raise the bulkheads, but only 15 to lower them.

The bulkheads create a division between the sea and the lagoon; the entire structure will require 78 ports:

- A row of 19 gates will protect the area of Malamocco;
- A row of 18 boxes will be located in the port of Chioggia;
- Two rows of 20 and will be required to area.

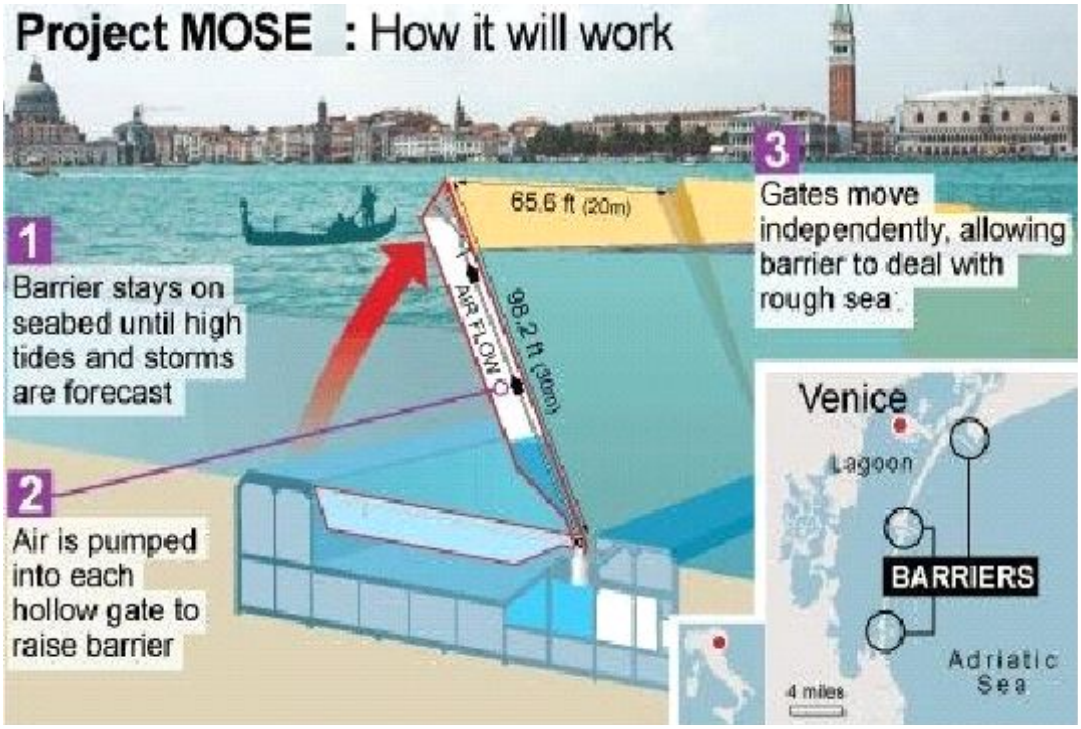


21 bulkheads seal the Lido

Beyond protecting the city and the lagoon from high tides, this project is expected to also protect the Adriatic coast of the lagoon through the development or preservation of:

- 45 km of beaches.
- 8 km of dunes.
- 11 km of jetties.
- 20 km of "Murazzi"
- 45 km of beaches

The project also involves the creation of locks which will allow for navigation even when the man made barrier is elevated.
For moderate to high tides (less than 110cm), the township of Venice has undertaken a project to raise the floor level of the buildings and of the embankments.




Because of environmental concerns, which also extend to the biosphere, not everyone is fully supportive of the Mo.SE project.

Those not in favour of this project have furnished the following information:

- 79 steel bulkheads that weigh 350 tons each with a length of 30 meters,
- reinforced cement base that weighs 12.500 tons,
- 12.000 concrete stakes,
- 5960 metal beams

and have questioned how all of these manmade elements can be compatible with the natural beauty of the surrounding environment".

## *5.3. Thermography of F. Severi Institute*

Along with the Comenius project our school has decided to join a second one related to energy saving; the project is named Eco-generation, in cooperation with the Edison Company and the environmental association Legambiente.

With Mr. Marco Boscolo, an engineer and a professor at the University of Padua, we made a thermographic survey of the entire school, both internally and externally.
These surveys were made in nine other Italian schools with the objective of publishing the results and ranking them in terms of energy efficiency.

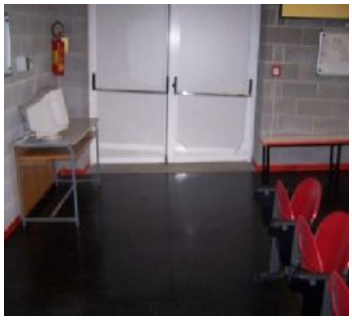
***Mr. Marco Boscolo***

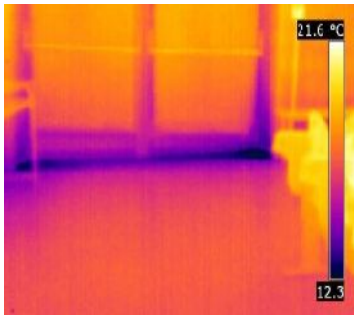
This project began 3 years ago and involves an" energy audit" of the participating schools with the intent of producing a list of those which are environmentally friendly: "Carta degli Obiettivi di Qualità".

A thermographic study is performed by using a special and expensive piece of equipment called thermocamera, that's to say a photocamera with a tin lens that detects infrared radiation due to heat emission.

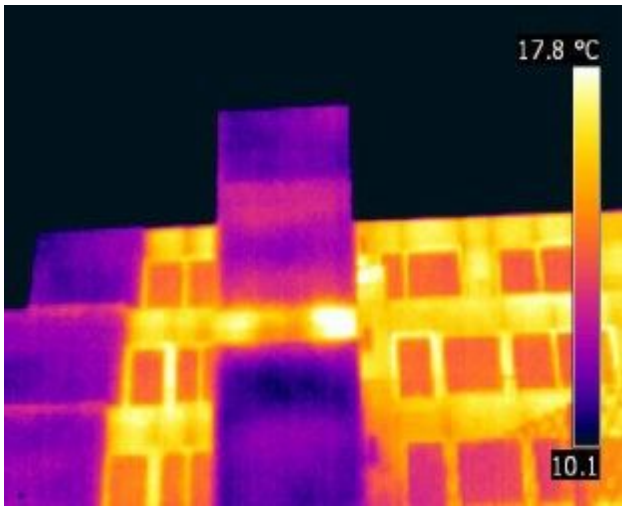
On a "thermal" picture hot spots are yellow, while the cold ones are purple.
Every time you take a "thermal" picture, you take another normal one for comparison.

This thermal photo, taken inside the school, shows the infiltration of cold air as a purple zone.






Thermal pictures of the black panels covering the outside of the building appear yellow thus indicating heat dispersion to the outside.




In conclusion, these technical surveys have revealed the thermal inefficiency of the school structure: most of the insulation of the windows and doors is ineffective.
This causes infiltration of cold air inwardly with dispersion of warm air outwardly and consequently we need more energy to heat the building.

# 6. SCHOOL INFORMATION

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