WHAT IS ENERGY

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Introduction

All organisms need energy to live. Energy is connected to all human activities: whenever we think or move, we use the energy that is stored in our body and all the objects that we use or that surround us need energy to work or needed energy when they were built. Energy illuminates us and warms our houses, allows us to move, feeds the tools we use to produce food, and so on.

Energy sources

All that produces energy is "an energy source". The Sun is the main source of energy for the Earth.
The Earth receives from the Sun an uninterrupted flow of energy that, as well as supplying all vital processes (both vegetal and animal), melts the ice and supplies the water cycle between the sea and the atmosphere; it produces the wind, favours the growth of those plants that during millions of years have transformed, together with animal remains, into fossil fuels, coal and natural gas.
In general, all the energy available on our planet derives, directly or indirectly, from the Sun: water energy, wind energy, chemical energy of fossil fuels (coal, oil and natural gas) and biomass (i.e. wood); even waves energy. Tides energy derives from the gravitational fields of the Sun, Moon and Earth. Geothermal and nuclear energy do not derive from the subsequent transformations of solar energy, but are related to the Earth formation.

Primary and secondary sources

The numerous existing energy sources can be classified in different ways. Primary sources can be used directly, as they appear in the natural environment: coal, oil, natural gas and wood, nuclear fuels (uranium), the sun, the wind, tides, mountain lakes, the rivers (from which hydroelectric energy can be obtained) and the Earth heat that supplies geothermal energy.
Secondary sources derive from the transformation of primary energy sources: for example, petrol, that derives from the treatment of crude oil and electric energy, obtained from the conversion of mechanical energy (hydroelectric plants, Aeolian plants), chemical plants (thermoelectric), or nuclear (nuclear plants). Electric energy is produced by electric plants, i.e. suitable installations that can transform primary energy (non-transformed) into electric energy.

Renewable and non-renewable

Some sources are renewable, i.e. they provide energy, which is constantly regenerated by means of chemical transformations (e.g. biomass) or physical transformations (e.g. water power, solar, wind power, etc.). In particular the sun, the wind, the water cycle, the tides, the heat of the Earth are non-exhaustible sources, which are always available and will never end. Biomass, instead, can re-generate within times that are similar to man's life. With reference to wood, for example, it is always possible to have some combustible available, even though sometimes it is necessary to consume a small quantity of it and reforest in those areas where trees have been cut down.

Non-renewable sources, instead, are characterised by long regeneration times, so long (millions of years) that after they have been exploited they are considered depleted. They are those energy sources that took millions of years to form, like fossil fuels (oil, coal, natural gas) or when our planet was formed, such as uranium. These sources, although there is still plenty of them, are limited and represent a sort of energy warehouse on the Earth.

Energy measurement

The units of measurement used by human beings to express the quantity of energy sources are numerous. There are measures for physical quantities and measures for the energy or heat content.
The official measurement unit for energy is the Joule (J). Among the most common units measuring energy mention should be made of the kilowatt/hour (kWh), used especially for electric energy (in fact it is used to calculate electricity bills). In order to measure the production of large electricity plants or the national consumption, the Terawatt/hour (TWh) is used, which corresponds to a billion kW/h.
The most common units measuring heat include the BTU (British Thermal Unit) and the kilogram calorie (kg-cal) and especially the Tonne of Oil Equivalent. The Tonne of oil equivalent is the most common at international level because it is connected to one of the most important and widely used fuels: oil. By measuring the different energy sources in terms of Tonne of oil equivalent, a comparison becomes possible and they can be aggregated, a vital operation to calculate how much energy a country consumes in a year or how much energy is still available under the surface (oil and natural gas fields and coal mines). But what is Tonne of oil equivalent? Basically, one Tonne of oil equivalent represents the quantity of heat which can be obtained from a tonne of oil. In practice, if we measure coal in terms of Tonne of oil equivalent, it means we are considering the quantity of coal capable of producing as much heat as a tonne of oil. (Let’s remember that: 1 Kcal = 4.186 J = 1,16 x 10^{-3} kWh = $1x10^{-7}$ TOE). How can we calculate the physical quantities corresponding to one Tonne of oil equivalent of coal or natural gas? In other words, how many kilograms of coal are needed to reach one Tonne of oil equivalent of coal and how many cubic metres of natural gas to produce one Tonne of oil equivalent of gas? To calculate that equivalence and use the units measuring physical quantities (kilograms, litres, cubic metres) of the different energy sources, we resort to calories.
We know that one tonne of oil contains 10-million-kilogram calories (kg-cal), whereas one tonne of pit coal contains 7 million kg-cal. Therefore, one Tonne of oil equivalent of coal, since it measures the quantity of coal containing as many kilogram calories as one tonne of oil, is equal to approximately 1.43 tonnes (measure of the physical quantity) of coal. Calculations are easier if we take, for example, vegetable fuels, containing 2.5-million-kilogram calories per tonne of material. In this case, to obtain 10 million kg-cal (the calorific content of a tonne of petrol) we need 4 tonnes of vegetable fuels; therefore one Tonne of oil equivalent of vegetable fuels correspond to 4 tonnes of vegetable fuels.
If we know the contents, in terms of calories, of the physical units measuring the different energy sources we can calculate all the Tonne of oil equivalent equivalents. The following table reports the

"Net Heat Value", i.e. estimates based on international average values leading to the conversion of the content of calories into the various units measuring the physical quantities of some of the most common fossil energy sources.

Forms of Energy

Albeit in different forms, energy is everywhere. However, the energy available which can be controlled, transformed and used by human beings (thanks to today's technology) is only a small part of the energy contained in the primary sources.

For example, energy can be found in the chemical bonds of oil, coal and gas (chemical energy turning into heat during the combustion process) or in the power of the blowing wind or water falling from the mountains (mechanic energy which can be transformed into electric energy) or the nuclear bonds (nuclear fuels) which, if they are altered through ad hoc processes caused by human beings, produce huge quantities of heat (thermal energy).

Work and heat energy

Energy mainly comes under two forms: work-energy and heat-energy. The former can be fully transformed into the latter, but not vice-versa because the heat tends to disperse.

The energy that produces work can again be divided into potential and kinetic energy.

Potential energy is connected to the respective positions of two bodies, for example the gravity pull increases insofar as the distance between a body and the centre of the Earth increases. Kinetic energy is the energy of the chaotic movement of molecules.

By throwing a ball up into the air, its kinetic energy increases. While moving upwards, the ball looses kinetic energy and increases its potential energy. When the topmost point is reached, the potential energy reaches its peak and the kinetic energy is nil, and the ball starts falling down. During its downfall, the ball increases its kinetic energy while the potential energy decreases. By bouncing on the ground, the ball transfers part of its kinetic energy to the Earth as heat.

Energy transformation

All energy forms can be transformed into other forms of energy: by burning coal we transform its chemical potential energy into thermal energy (heat). Thanks to the steam engine, the heat can in its turn be transformed into kinetic energy, i.e. the motion of the locomotive.

Thermodynamics is the science studying the transformation of energy into work and vice versa. It is based on two principles valid only within closed systems such as the Earth. The Earth is a closed system because it can exchange energy with outside but cannot exchange matter. If it were not able to exchange energy either, it would be defined an isolated system. If it exchanged matter too it would become an open system.

First principle of thermodynamics. There is a natural law limiting these transformations, i.e. the law on the conservation of matter, according to which energy cannot be created nor destroyed ("nothing is created and nothing is destroyed"). The energy can be transformed from a form into another but the sum of the different forms must remain unchanged. Therefore “nothing is created nor destroyed, everything is transformed”.

Second principle of thermodynamics. Whereas the first law of thermodynamics deals with the global balance of energy, the second law deals with its transformations and its natural tendency to move towards more degraded forms, which cannot be used any longer. Actually, the second law of thermodynamics includes two wordings. The first states that the heat always moves from a warmer to a colder body, never the other way round. The second unveils the natural tendency to the dispersion of heat, i.e. that the heat from a source cannot be fully transformed into work. This does not mean that the total quantity of energy present in the universe is decreasing, rather that its ability to work is.

The thermodynamic function assessing the degree of energy dispersion is called “entropy”. Entropy in the universe tends to increase to reach a state of balance in which the total degradation of energy is achieved corresponding to the complete inability to work. Fortunately, biological systems are open systems, which thanks to the incoming of energy from outside, restore the positive global energetic balance.

Energy efficiency

At this point the notion of efficiency is to be dealt with. As a matter of fact, energy resources are precious goods, which are to be used efficiently and effectively. A basic concept to assess the quality and waste of any human activity is efficiency. Efficiency assesses which part of the energy and materials making up any action or process was successful and which part was lost. Energetic transformations too always lead to some losses. The efficiency of an energetic transformation is measured by dividing useful energy (the difference between the energy input and dissipated or wasted energy) by the energy input. If the efficiency of an energetic transformation amounts to 60%, this means that out of 100 energy units included in a process, 60 were transformed into usable energy forms, whereas the other 40 are transformed into non-usable energy forms.

Two meaningful examples can be produced as regards the efficiency of the petrol we use for our cars and the thermal transformations taking place in a thermoelectric power plant. When we travel by car less than one fifth of the chemical energy contained in the petrol is transformed into mechanic energy, i.e. motion. The remaining part is transformed into heat, which cannot be used anymore and is dispersed through the radiator or is discharged through the exhaust gas or warms the passenger compartment. Another part of the energy produced is transformed into heat owing to the friction among gears and is dispersed. The total quantity of energy at the beginning and the end of the process does not change, whereas the its form is changed (from chemical energy to motion and heat) and generally degrades into forms which cannot be used to produce work any longer.

In thermoelectric power plants (where fossil fuels are burned to produce electric energy the transformation and use of which by the final users is easier) the average efficiency amounts to 40%. This means the out of 100 energy units contained in coal, oil or natural gas, only 40 are transformed into electric energy, whereas the remaining 60 are transformed into low temperature heat which often cannot be used. In state-of-the-art thermoelectric power plants using natural gas, new technologies allow higher efficiency levels, i.e. approximately 65%.

Sustainable use of resources

When can it be said that use of a natural resource is sustainable? Generally we can say that a natural resource is used by man in a sustainable manner when, knowing its capacity to reproduce (consider fish as a natural resource) or to maintain a determined quality (for example the purity of the air we breathe) it is not exploited more than a determined threshold. When use of a resource exceeds the said threshold, it means that there will be a progressive and dangerous impoverishment, in terms of quantity (the global population of fish drops to a limit below which the species is destined to disappear) or in terms of quality (the air is so polluted that it is bad to breathe and causes severe diseases among human beings). If this "impoverishment" of the natural resource is definitive (disappearance of the species) we say that an "irreversible" damage has been provoked, i.e. it is not possible to go back and bring the species back to life. Impoverishment, instead, is considered "reversible" if it is possible to go back and recover the natural resource (polluted air can become breathable if polluting substances are no longer emitted).

Actually the concept of sustainability can only be applied to renewable natural resources that can be reproduced in times that belong to a "human scale" (for example, firewood). For non-renewable sources, such as fossil fuels, it is best to talk of optimum exploitation. In other words we must try our best to use these in an efficient manner (making them last as long as possible) and in the meantime, find technologies that allow the exploitation of alternative sources in their place, which may even be characterized by a "renewable" nature (for example to replace the energy produced by fossil fuels in the future with solar energy, which is a renewable source).

Energy issues

The development of our society is tied to energy consumption. Without energy, man would not have been able to reach the present level of wellbeing and quality of life. Without the availability of sufficient energy resources future economic development would be jeopardized. Notwithstanding recent increases in prices, energy is still "cheap". All of us therefore are used to make use of large amounts of energy without thinking much about it, this is because we are not aware of our actual needs. The world energy panorama shows constant energy reserves, relatively stable prices, which however tend to grow, and a strong increase in the demand, particularly in the developing countries. However fossil fuels, which are the source of energy that has been utilized mostly up to date, have a downside. First of all they are destined to become depleted sooner or later. Certainly, the ascertained reserves of fossil fuels have gradually increased during the course of the last 25 years, with the discovery of new deposits and a more exhaustive exploitation of the existing deposits, made possible by modern technologies. Unlike what was believed at the end of the Seventies, a physical depletion of these "fossil" resources is not imminent, we can still count on a few years (about 110 for coal, 58 for natural gas, 51 for oil) to develop alternative sources of energy.

The problem therefore has only been postponed, but not for long! Another fundamental problem is that fossil fuels in many cases are a source of pollution of the environment, and in particular of the air. This problem also sums with the disparity between nations, with regard to the level of wellbeing that has been obtained. Distribution of energy consumption is greatly anomalous: 20% of the world population (in the richer countries) uses 80% of the energy that is produced. This situation is strongly in contrast with the fundamental principles of equality among peoples, sustainable development and therefore global quality of life.
Countries like Africa or India are very poor at present (the pro capita income in some areas is greatly below subsistence level) and they yearn to increase their level of wellbeing. In order to do so, however, they need to utilize energy in greater amounts (for more factories to operate, to guarantee sufficient light and heating for the families). Where will this additional energy come from? Probably if they follow our development model that uses mostly fossil fuels, there will be a marked impact on the environment and, as many experts believe, in the future, severe climate changes (the so-called "greenhouse effect") may take place with consequences that are extremely harmful for human beings. The consequence is a "non-sustainable" development from the point of view of the environment. On the other hand, we cannot prevent the poor countries from reaching an adequate economic and social development, also because the economic and social imbalance that exists between nations is a potential source of political instability, wars and strong migratory flows. Maintaining the present situation or a solely partial improvement would, in this case, lead to a non-sustainable development from an economic and social point of view. How to solve these problems? Since their extent is international, the countries of the world are trying to reach an agreement, through all the international institutions that can have a fundamental role.

Effects on the environment

The energy issues arose in relation to the environmental issues. Use of energy greatly modifies the state of the environment, and the effects can be of a local, regional and global nature. In this perspective, that is valid on a planetary scale no less than on a national and regional scale, right up to each one's home, the protection of the environment becomes a primary objective to be achieved in the development of the different energy systems. In order to guarantee the future generations, the wellbeing that has been obtained up to now, a type of development that is different from the past is necessary, a development that utilizes energy better (rational use), less energy (efficient technologies and less waste) and that uses forms that are substantially different from the present ones.
With regard to the environment and energy, one of the most important problems, which is the most well-known, is the problem regarding the decrease in gas emissions that provoke the greenhouse effect, which are caused mainly by the production of energy when burning coal, oil and gas. The way to find a solution to this problem of environmental pollution is still a long one, but the steps that have already been taken to reach an agreement on an international scale are many. From 1972 to date in fact a number of conferences have been held and numerous international agreements

have been signed to protect the environment, and in many of these topics related to the utilization of energy and sustainable development have been discussed.

Possible solutions. We can act on many fronts. Firstly, the economically developed countries can decrease their emissions from the production of energy, as follows:

- improving the performance of the combustion processes (less combustible burnt in order to obtain the same level of energy) and reducing wastes;
- introducing new technologies that “hold back” the polluting substances, avoiding their dispersion in the air;
- replacing sources of energy that are highly polluting with others that are less polluting or not polluting at all (among which almost all the renewable sources). In this way the level of economic wellbeing of these countries would not decrease, instead there would be a decrease in the impact on the environment.

Secondly, the developing countries can be helped by supplying them with better technologies that are currently available, those with a low environmental impact and high performance. There however still is the problem of the depletion of fossil fuels in the long term, which is the real challenge for “sustainability” that mankind must face, and its solution can only come from research and large scale utilization of renewable and clean sources of energy.

Hydrocarbons and climate change

Fossil fuels (oil, gas and coal) are, today, the most utilized sources worldwide for the production of energy. They account for over 80% of the energy consumption of the planet. Their combustion, however, involves the emission of large amounts of carbon dioxide (CO_2), whose increasing concentration in the atmosphere is considered the principal cause of climate change.

The need to satisfy the growing demand of energy on a global scale and in particular the demand of the emerging countries, is balanced by the need to contrast the risks of an impact on the climate deriving from the increase in CO_2. In order to decrease CO_2 emissions, there are various ways. The first, which can be carried out in the short term and which can be implemented immediately is energy efficiency, in other words use of technologies that enable the consumption of less energy for an equal amount of services offered. Another possible solution is to use the renewable energies, which at present still have a modest role. In fact, biomasses and assimilated materials (wood products, waste, etc.) account for 10% of the total energy requirement, hydroelectric energy accounts for 2% while the other renewable energy sources (solar, wind, geothermal, etc.) even though rapidly growing, satisfy only 1% of the world demand of energy. Also, nuclear energy is a possible solution in order to contrast climate change as no CO_2 emissions are produced. Currently nuclear energy accounts for 6% of the world demand of energy, a share that is still not competitive when compared to the fossil fuels.

Comparing hydrocarbons. Among the fossil fuels, methane currently seems to be the one that will have a growing utilization in the near future, due to the fact it is relatively abundant and due to the fact that it is relatively “clean”. Its molecule consists of 4 atoms of hydrogen and one of carbon (CH_4). When it burns this is the hydrocarbon that produces the smallest amount of carbon and for this reason it is less harmful for the environment. It produces CO_2 emissions that are 25% less than petrol, 16% less than liquid propane gas (LPG), 30% less than diesel oil and 70% less than coal. Its capacity to form ozone is 80% less than petrol, 50% less than diesel oil and LPG. Furthermore, emissions from combustion do not contain carbon deposits, benzene and particulate matter PM10, unlike benzene and diesel oil. Among all the fossil fuels, methane is surely the most "ecological". It is estimated that its use shall increase greatly in the near future.

The technology used for the geologic capture and sequestration of CO_2 (CCS)

Since fossil sources are destined to be the protagonists of the world energy scenario for many more years, we must act immediately, directly on their utilization, in order to reduce CO_2 emissions with regard to their combustion. CO_2 Capture & Storage (CSS) technology enables the capture and sequestration of the CO_2 generated by the use of fossil sources, reducing the emissions in the atmosphere.

With regard to the capture of CO_2, there are technologies that are already well known and utilized by the petrochemical industries and others are being developed. At present, CO_2 can be captured in three principal ways.

- **post-combustion**: in post-combustion capture, CO_2 is separated from the combustion fumes, first purified from the pollutants with modern treatment systems. This separation takes place using a solvent that absorbs CO_2 at low temperatures, that it subsequently releases for heating, generating a practically pure CO_2 current;
- **pre-combustion**: in pre-combustion capture, CO_2 is removed before combustion. The fossil fuel is gasified with oxygen to generate hydrogen and CO_2. The CO_2 is separated, while the hydrogen is utilized to generate electricity in a combined cycle, or for other uses as an energy vector;
- **oxy-combustion**: with this method, combustion of fossil fuels is fed with oxygen instead of air, thus generating a gaseous current that consists mainly of CO_2 and water vapour. The water vapour is separated through condensation and the concentrated CO_2 current can be compressed and stocked.

Once it has been captured and compressed, CO_2 is transported in pipes up to the **storage** site and injected to a depth of about one kilometre underground. Depleted hydrocarbon deposits and saline aquifers (deep bodies of water with an enormous capacity to absorb CO_2) are considered suited reservoirs for permanent geological confinement of carbon dioxide.

The CO_2 is injected at high pressures, so that it reaches the so-called "supercritical" behaviour, in other words a state that is similar to a gas, due to its capacity to spread rapidly in the porous surfaces of the geological formation, and that is also similar to a liquid, in terms of density, and therefore a volume that can be stored. In the depleted oil or gas fields, the CO_2 fills the pores in which the hydrocarbons were trapped. In case relevant amounts of hydrocarbons are still in the deposit at the time of injection, the CO_2 can also favour the additional production of oil or gas (Enhanced Oil Recovery - EOR e Enhanced Gas Recovery – EGR processes).

Costs and feasibility. In the practical application of CCS there still are difficulties to be overcome, that are related prevalently to the costs. The initial stage of CO_2 capture has a significant energetic and economic cost, that covers approximately 80% of the total costs of the technology. In order to act positively on this phase, it is necessary to operate on plants that emit large quantities of CO_2. Once the CO_2 is separated, it is transferred to the storage site, which must not be very distant in order to minimize the costs. For distances of a few dozen kilometres, transportation accounts for about 15% of the total cost. The final stage in which the CO_2 is injected into the ground accounts for 5% of the total cost. This, however, is the most delicate stage, from the point of view of safety, and it significantly affects the sustainability of the entire process. The injection of CO_2, however, is a process that is well known in the oil drilling world, that knows its technological and geological characteristics well. In fact, for decades the oil companies have been re-injecting CO_2 derived from the treatment of acid gases into the hydrocarbon deposits in order to maintain the pressure and to support production.

The knowledge and experience matured in the oil sector can be applied to CO_2 Capture and Storage technologies, for example in the choice of the most suitable sites for carbon dioxide sequestration. In fact the oil sector has a good knowledge of characteristics such as the porosity of the storage site, that define the potential volume that can be stored, and help to evaluate the consequences on the mechanical stability of the geological formation and any seismic effects; and to identify the characteristics of the caprocks which guarantee well sealed sites for the injected CO_2 over the years. Use of saline aquifers as CO_2 reservoirs is an option that is less mature at present, it requires the development of more know-how as these basins have not been as widely studied as the hydrocarbon deposits. On the other hand aquifer deposits are also present in areas where oil and gas are not produced and they offer a potential storage that is considerably greater than deposits that have become depleted or are on the decline.

Saving energy

In the improved utilization of natural resources (and not only energy), research and technological innovation, national and local energy policies, and especially culture and behaviour of the population, will surely have a fundamental role.

A reduction and correct management of waste, an appropriate use of electrical appliances, an intelligent management of household lighting and of heating in offices and apartments, use of public transport instead of one's own car, all these are actions that, if put to use by all of us on a daily basis, will lead to a decrease in the waste of energy, an increase in the performance of the overall energy system and especially a "saving" in terms of natural resources, the environment and also of money. Each one of us, therefore, can strive to save the present energy sources, by using innovative technologies, but also adopting small improvements in our daily life. To do one's best to realize a sustainable development however does not mean giving up what one has, but rather to avoid wasting.

What you can do

Our small daily actions can contribute to energy saving, and these include some ways to behave with regard to the use of "household energy", i.e. the energy used for heating and electricity. It is pointed out that energy for domestic use absorbs more than 18% of the national energy requirements and is responsible for approximately 27% of the polluting emissions. We can try to save up to 50% of the household energy that we utilize.

Each of the electrical appliances in our homes uses energy. It is important to read the energy efficiency label when buying an item and prefer the appliances that have a lower energy consumption. We must always make sure that the models that we are being offered are high efficiency products and they must bear the IMQ (the Italian Quality Control board) mark or another European mark or guarantee. Furthermore, if the electrical appliance is strong and repairable, it will last longer and costs for its disposal will be avoided. To improve the efficiency of an energy system means:

- for heating in the homes, to decrease the amount of energy required to heat one square metre;
- for the refrigerator, to decrease the amount of electricity utilized in one day;
- for the gas oven, to decrease the energy required for its operation for a whole day;
- for the air conditioner, to decrease the amount of electric energy utilized in one day.

Here below, a series of actions are listed, that will help to save energy in the homes without having to renounce comfort and wellbeing.

Electric current

A considerable amount can be saved in electric energy if users are well-informed and their behaviour reflects their awareness, and by adopting the so-called "good practices", such as:

- do not leave the lights on in rooms that are not occupied;
- choose chandeliers with less bulbs (for an equal amount of lighting produced, chandeliers or lamps with a number of bulbs consume more energy than those with one light bulb only);
- position the refrigerator or the freezer in well ventilated places, far away from sources of heat;
- regulate the thermostat of the refrigerator or of the freezer at an intermediate temperature (the colder positions require a useless increase in the consumption of energy 10-15%);
- for washing machines, wherever possible use low temperature washing cycles;
- for TV sets, video recorders and electronic equipment in general, avoid leaving these units in the stand-by mode.

By adopting these simple rules, which do not involve any monetary investments, it is possible to obtain significant energy saving, amounting to about 10-20%. Significant saving of energy can also be obtained by replacing standard equipment with high-efficiency equipment (in the Western Countries electrical appliances utilize almost 50% of the total electric energy produced). It is possible to intervene both on the lighting and on the electrical appliances.

With regard to lighting, by replacing incandescent light bulbs with low energy consumption light bulbs (a light bulb is more efficient than another when it consumes less energy in order to obtain the same amount of lighting) energy consumption for lighting decreases 80%. With regard to electrical appliances, high efficiency models are available on the market since a long time. In the shops, refrigerators, freezers, washing machines and dishwashers are provided with an energy efficiency labels. These labels that have become compulsory following an EEC directive, define seven classes of energy efficiency, from A (low energy consumption) to G (high energy consumption). High efficiency electrical appliances can consume up to one third of the electric energy consumed by the electrical appliances in the lower range. State of the art models (refrigerators, washing machines, dish washers) allow an overall saving of 74% of consumed energy.

Saving energy when washing clothes

Washing machines consume about 25% of the electric energy for domestic use and every year they produce polluting emissions that have been calculated to be 7 million tons of carbon dioxide, 65,000 tons of sulphur dioxide and 20,000 tons of nitrogen oxides. There are models equipped with a double water intake (hot water and cold water, depending on the selected programme) that allow greater savings, while the “wash & dry” models use a lot of energy.

Some practical suggestions:

- choose models which have a half-load programme, and a thermostat that can be regulated;
- clean the filter and the detergent dispenser drawer using anti-scaling agents (e.g. sodium bicarbonate);
- avoid using the prewash setting and select low temperatures (30-60°C);
- prefer washing in the evening and night because the power plants are used less intensely and can provide energy without any power overload.

Saving energy in the kitchen

The dishwasher. For a washing-cycle at 65°C, a dishwasher consumes an average of 20-30 grams of detergent, 1.5-2 kWh and it produces about 1 kilogramme of carbon dioxide. Remember not to position this electrical appliance near the refrigerator and make sure there is a BIO button so that it can be used with detergents that do not contain phosphorus (a very polluting agent).

Some practical suggestions:

- clean the filter and the small holes of the rotating arms;
- regularly fill salt in the salt compartment so that the anti-scaling device continues to work efficiently;
- use rapid or economical low-temperature (max. 50°C) washing cycles;
- do not select the hot-air drying option, save 45% of the energy of a complete cycle by opening the dishwasher door and letting the dishes dry on their own, that represents about 5% of the electric energy for domestic use.

The refrigerator. The refrigerator is the electrical appliance that remains constantly on and that uses more electricity than all the other appliances. It is important that we choose a refrigerator that has the capacity and the technical characteristics that are suited to the real needs of the family unit (e.g. 100-150 litres for one person, 220-280 litres for two people). We must not forget that till not long ago, all the refrigerators contained gases in their cooling circuits that are responsible for the depletion of the ozone layer.

The refrigerator must be positioned far from sources of heat (dishwasher, oven, cooking range, radiators) and at least 10 centimetres away from the wall in order to guarantee ventilation that is necessary for the cooling coil. The dust must be cleaned periodically from the cooling coil, in order to guarantee a good cooling performance.

Some practical suggestions:

- periodically check the seal of the rubber refrigerator door gaskets;
- defrost the freezer when the layer of ice is more than 5 millimetres, because electricity consumption can increase up to 30%;
- regulate the thermostat according to the room temperature;
- do not put hot food or uncovered liquids in the refrigerator, because this causes an increase in the layer of ice on the sides;
- avoid filling the refrigerator excessively so that the air can circulate freely.

The oven. Currently technology guarantees excellent cooking performance and remarkable energy saving with gas ovens, compared to electric ovens. Self-ventilated models provide a more rapid and uniform heating.

Some practical suggestions :

- use all the oven shelves;
- avoid opening the oven when it is cooking;
- the oven can be turned off a little before the end of the cooking process, leaving the food to continue cooking inside the oven.

Saving energy in the rest of the house

The air conditioner. In order to protect our health, it is good to keep the filters clean. These can accumulate harmful substances such as bacteria and dusts. Furthermore, it is advisable not to set the temperature at a level that is very different from the temperature outside, because it is equally harmful for us, and it is very costly from the point of view of energy. In fact, it would be better to use fans or dehumidifiers, and favour cooling the house by keeping the windows open at night and allowing the air to circulate.

The iron. Lighter irons, with steam, and an anti-scale device and 1200 watt power are sufficient for domestic use. Remember to regulate the temperature according to the type of material to be ironed. Today there is an extra instrument to inform users/consumers and push them towards energy saving, the energy efficiency label which, as required by the law, must be attached to all household electrical appliances. The label also has information regarding the energy consumption of the unit and the related energy efficiency class, which ranges from the letter A, where energy consumption is lower to G where it is higher. From today, therefore, saving energy is increasingly easy. ***TV.*** The television set is an electronic unit that is turned on for many hours a day, as in the case of computers. We must remember to turn these units off when we do not use them and, as soon as possible, we should activate the energy saving functions and turn off the monitor in case of interruptions of over 10 minutes. Radios and portable recorders, watches, cameras and cell phones are generally operated with batteries. Batteries are a dangerous waste and are difficult to eliminate, as a consequence use rechargeable alkaline or lithium batteries, and remove them from the unit when not utilized. However, we must pay attention at the time of purchasing items - some torches, watches and calculators use solar energy.

Stand-by. Stand-by systems are a true waste of energy, for instance 15W are required to make a compact disk play, and 11W are consumed just to keep the CD player turned on! Most modern electrical appliances (TV, video recorders, computers, microwave ovens, etc.), when not in use can be left in the stand-by or sleep mode, which is usually noticeable because of the small lights that remain turned on, on the equipment. For example, the television remains in stand-by when it is turned off using the remote control and not the on-off switch. In this mode, consumption of electric energy is reduced, but it is not turned off after the unit has been utilized actively. Even electrical appliances that are not operating continue to consume minimum quantities of electric energy if they are connected to the electric main; consumption is totally stopped only when the plug is removed from the socket connected to the main or, in case the equipment is plugged into a multiple electrical outlet, when the switch is turned off. Overall, electric energy consumption in the stand-by mode is not negligible, if you always remember to turn off electrical appliances when they are not in use, you will easily save about 8% of your annual consumption of electric energy.

How to eliminate any waste of energy in the electrical appliances when they are not in use? Purchase a multiple electrical outlet and connect your electrical appliances to it. By turning the switch off, you will completely cut off the electricity consumption of the appliances. Also remember to disconnect all battery chargers when they are not in use.

Lighting

The European Union has ruled to gradually banish all incandescent bulbs (which regards the production of new bulbs) with the following schedule:

- from September 2009, the production of 100 W incandescent light bulbs or more, and all the bulbs with frosted or opal glass is prohibited;
- from September 2010 the production of 75 W incandescent light bulbs is prohibited;
- from September 2011 the production of 60 W incandescent light bulbs is prohibited;
- from September 2012 the production of incandescent light bulbs of all powers is prohibited;

Exception is made for incandescent light bulbs made for specific purposes (e.g. refrigerators, ovens, etc.). A 100 watt (W) incandescent light bulb produces the same amount of light as a 20W compact fluorescent bulb; this means that the two bulbs emit a similar luminous flux (measured in lumens,

lm). The lumen/watt ratio indicates the lighting efficiency of a light source. While 100W incandescent light bulbs are characterized by a modest lighting efficiency (14 lm/W), because about 80% of the electric energy is transformed into heat and only the remaining 20% into light, 20W CFLs have a much higher lighting efficiency (60 lm/W).
The more efficient operating mechanism leads to a decrease of up to 80% in the consumption of electric energy for an equal luminous flux. Low consumption light bulbs cost slightly more, but their average life span is remarkably longer than the traditional light bulbs (10,000 hours vs. 1,000 hours of the incandescent light bulb). Replacing the incandescent light bulbs can be a great advantage, the higher cost for purchasing the same is however recovered in a very short amount of time. Other initiatives:

- Turn off the lights if they are no longer needed;
- Regularly clean the lighting equipment: the dust, greasy smoke and vapours of the kitchen can decrease the amount of emitted light up to 20%.

The heating system

With regard to the heating system of houses, the conditions of a beautiful day in spring should be created, 20 degrees centigrade, humidity about 50% and good circulation of air:

- only slightly heat the rooms that are not used at all, or which are used rarely;
- during the day, keep the temperature at 20 degrees centigrade, at night 16 degrees centigrade (1 degree less is equal to 5-7% savings) and however respect the limit set as maximum temperature inside the house and the period of the season in which the heating systems can be turned on, which are both regulated by the different Town Councils;
- in the evenings, close the shutters or lower the shades and close the curtains, unless these also cover the radiators;
- during the day do not prevent the sun’s rays from shining through the windows;
- do not cover the radiators with furniture, curtains or other objects (40% of the energy is wasted);
- always place a board made of isolating material between the wall and the radiator;
- ventilate the rooms shortly but thoroughly, open the windows for a few minutes only, two or three times a day;
- apply sealing materials on the windows wherever the cold draft comes through the windows;
- isolate the attic;
- use isolating materials to cover the pipes that bring hot water from the boiler to the radiators;
- mount thermostatic valves on the radiators to control the flow of hot water depending on the temperature that is recorded in the room;
- check the boiler at least once a year and at the time of purchasing a new heating system, choose the highest efficiency boiler (by improving the performance, 10% of fuel can be saved per year);

- if the heating system needs to be changed, prefer systems that use renewable energy sources (biomasses) or assimilated systems (cogeneration and district heating), or methane gas;
- in apartment buildings with central heating systems, install a system to account for the heat utilized by each apartment. In this way it will be possible to share the expenses among the various users, in proportion to the amount utilized by each.

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