

BEHIND ENERGY

Energy@School Teaching worksheets



FOSSIL FUELS	2
RENEWABLE SOURCES	<u>6</u>
EXTERNALITIES	9
INTERNATIONAL AGREEMENTS ON CLIMATE	11
DIVEST AND INVEST	13
ENERGY EFFICIENCY	15
SUSTAINABLE MOBILITY	16
GREEN JOBS	17





FOSSIL FUELS

What are they?

Fossil fuels are fuels formed by natural transformation, under suitable pressure and temperature conditions, over millions of years, of organic substances buried over geological eras, in increasingly stable molecular forms and rich in carbon.

Fossil fuels contain energy that originally came from the sun, captured in the biosphere over geological periods by plants through photosynthesis and by single-celled aquatic organisms such as protozoa, cyanobacteria or, indirectly by animal organisms through the food chain.

Fossil fuels are considered **non-renewable sources** because it takes millions of years for them to form; therefore they are not compatible with human consumption rates. Fossil fuels are exploited at a much faster rate compared to their regeneration speed.

Forecast

Although the use of fossil fuels will decrease all over the world in the next 25 years, they will **remain** the main source of energy at least until 2040. According to the International Energy Agency (IEA), despite the growth of renewable energy and nuclear power, fossil fuels will still be the main source of energy in the next two decades. This forecast is based not so much on electricity generation figures, but rather on the use of fossil fuels for thermal power and transport.

The 2040 scenario described in the report shows a sharp increase in renewable sources and energy efficiency, but it does not envisage a quick enough transition as to free us from dependence on fossil fuels, or contain global warming within the safe limit of 2°C above pre-industrial levels.

What if we burnt all fossil fuels?



If all currently available carbon sources, estimated in about 10,000 billion tons, were burnt, the sea level would go up by about 58 metres over a few thousand years, thus causing areas currently inhabited by at least one billion people to disappear under water. If we consider a time span of one thousand years, the sea level would go up by "just" 30 metres. These data result from a long-term simulation performed by the Potsdam Institute for Climate Impact Research, in

Germany and by the Carnegie Institution at Stanford, United States, published in "Science Advances".



If we burnt all known reserves of fossil fuels, the Earth's average temperature may go 8°C above pre-industrial levels, and the Arctic would be the hardest hit, with temperatures potentially increasing by up to 17°C. This is the conclusion reached by a research study performed by the University of Victoria, Canada and published in Nature Climate Change. This study has developed scenarios for the next three centuries assuming that we continue to burn oil, gas and coal with no efforts to reduce emissions.

At a similar pace, researchers estimate that in 2300 about 5 thousand billion tons of carbon would be released into the atmosphere, mainly in the form of carbon dioxide. In this scenario, CO₂ levels would be about 2 thousand parts per million (ppm), five times more than current levels and seven times higher compared to pre-industrial levels. This would cause a temperature increase between 6.4 and 9.5°C compared to pre-industrial levels. In the Artic, which is warming up faster than the rest of the world, temperatures would go up by 14.7-19.5°C.

Other expected effects of unrestricted exploitation of fossil fuels include increased rainfall in the tropical Pacific area and possible drought in other areas such as Australia, the Mediterranean, Southern and Northern Africa, Amazonia and Central America. The impact on polar and tropical ecosystems and on barrier reefs would be enormous.

Reducing the use of fossil fuels

The proportion of carbon dioxide (CO_2) in the atmosphere is linked to the Earth's temperature. As the proportion of CO_2 goes up, the average temperature increases.

Fossil fuel exploitation around the world has made it possible to achieve economic and social development and to develop agriculture and industry; the human population has grown sevenfold. On the other hand, it has caused a 14 cm increase in the sea level and a 1°C temperature increase in the last one hundred years.

To **prevent temperatures** from exceeding the **2°C** increase and the sea level from increasing by over one metre, humans should **reduce emissions from fossil fuels.** It is difficult to calculate by how much they should be reduced; in fact, scientists' discussions are mainly focused on this issue.



However, it seems clear that in order to keep global warming within the 2°C increase, above which irreversible environmental damage would occur, with catastrophic consequences, the use of fossil fuels must be reduced faster than planned.

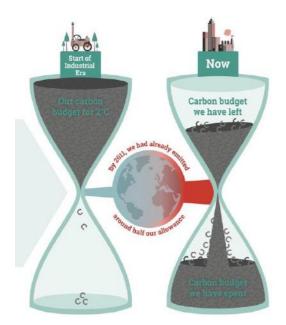


The carbon budget

The global carbon budget is a balance between what animals, including humans, emit and what plants and algae can absorb.

For simplification purposes, climate scientists have translated this objective into billions of tons of carbon dioxide that may ideally be released into the atmosphere to have a reasonable possibility to keep global warming within the 2°C.

In other words, we are allowed to emit only a certain quantity of carbon dioxide, forever, and this is our "carbon budget".



According to a study published in <u>Nature Climate Change</u>, the Earth's carbon budget to avoid exceeding the 2° C limit, from 2015 on, is between 590 and 1,240 billion tons of CO_2 . According to previous estimates, the maximum amount was 2,390 billion tons, almost twice as much.

According to the Global Carbon Project, in 2014 global CO_2 emissions amounted to about 36 billion tons. This means that at this pace, we will use up our budget of 1,240 billion tons in the next 34 years.

From 2050 on, all Countries of the world should have reached 0 emissions to prevent global temperatures from being more than 2°C higher than pre-industrial levels.



How many emissions do our activities produce?

The environmental footprint of a smartphone, that is to say the quantity of greenhouse gases released to manufacture, package and deliver it to the market, is about 57 kg of CO_2 , as much as a small petrol car travelling 500 km. A computer has a much higher environmental impact, 1,015 kg of CO_2 , equal to emissions from a car travelling about 9,000 km.

The Internet pollutes as much as the entire world's civil aviation.



According to the French Environment and Energy Management Agency (Ademe), sending eight emails causes the same pollution, in terms of CO₂ emissions, as travelling one kilometre by car. The use of e-mails has an impact on energy consumption and therefore on greenhouse gas emissions. Based on their figures, a 1 megabyte e-mail emits about 19 grams of CO₂, taking into consideration energy consumption by the computer and by the servers involved in data traffic.

To give an example, a company with 100 employees sending an average of 33 e-mails a day each, for about 220 days a year, produces about 13.6 tons of CO_2 , equal to 13 Paris-New York return trips by plane. Therefore, the Internet pollutes as much as the entire world's aviation.



RENEWABLE SOURCES

What are they?

Renewable sources are sources of energy that can replenish themselves, that cannot be depleted at human consumption rates and **whose use does not impair natural resources for future generations.** So far, they have been considered as an alternative to traditional fossil sources and they are largely clean because they do not release any harmful or greenhouse gases such as carbon dioxide.

Renewable sources include **sun**, **wind**, **water** and **geothermal resources**, **tides**, **waves** and transformation of **vegetable products** or organic and inorganic **waste** into energy.

Renewable sources are one of the **main solutions to reduce CO₂ emissions** generated by energy consumption and they are the basis for a **distributed generation** system, that is to say distributed power plants located where renewable energy sources are available. This generation system makes it possible to cut transport costs, increase supply security and generate benefits locally, including economic improvement, by increasing local employment.

The disadvantage of renewable resources is that they **do not ensure constant energy generation** and cannot be planned, as happens with power plants fed by fossil fuels.

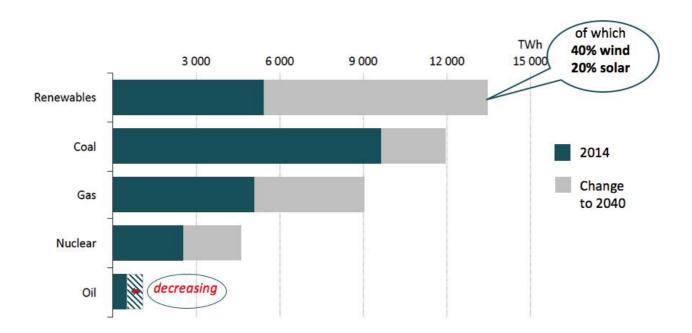




Forecast

The role of renewable sources is bound to increase considerably in the next two decades, but not as much as it would be necessary. According to the International Energy Agency, the world energy demand in 2040 will be up by 37%, even though the growth rate will slow down due to a lower energy intensity (ratio of energy consumed to GDP).

In 2040, renewable resources will account for 50% of new power generation and in 2030 they will overtake coal, to become the first source of electricity.



At the end of 2015, the renewable capacity installed worldwide was 1,985 GW, up by 8.3% in the last year. More than 80% of the renewable capacity is in Asia, Europe and North America; in Asia alone, it increased by 12.4% in 2015.

Costs: fossil versus renewable sources

New technologies make it possible to obtain renewable energy at an increasingly competitive price compared to fossil fuels.

Coal and gas-based energy costs will remain low for long since supply exceeds demand. However, large investments in renewable sources, coupled with development of battery technology to store energy will help reduce green power costs.

Renewable sources will become the cheapest sources of energy in many Countries by 2020 and in most parts of the world by 2030.

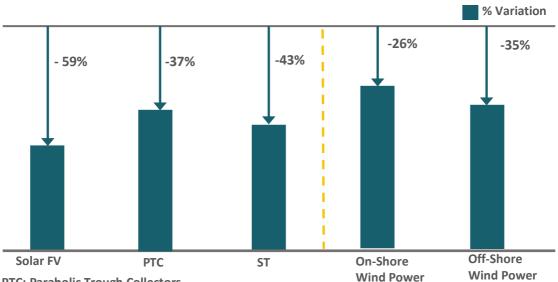


The average price of sun and wind power is bound to collapse. The cost of photovoltaic modules is now 80% lower compared to 2009 and the cost of wind turbines dropped by 30-40%. The cost of electricity from renewable sources will continue to decrease.

Photovoltaic power is expected to show the biggest drop, with costs down by 59%: a kWh produced by this technology will cost 5.5 cents of a dollar in 2025, as opposed to 13 cents now. According to the Agency, on-shore wind power costs may drop by 26%, the cost of solar thermal energy with parabolic trough collectors may go down by 37% and that of power tower design by 43%.

Cost reductions can take place if supported by suitable regulations to reduce transition costs and by streamlined regulatory processes for projects.

Potential decrease in sun and wind power costs globally



PTC: Parabolic Trough Collectors

ST: Solar Tower



EXTERNALITIES

Externalities are positive or negative effects by a manufacturing or consumption activity of any entity on the manufacturing or consumption activity of another entity, with no impacts on consumer prices.

If we apply this concept to the energy sector, it means that energy generation and consumption produce effects in terms of environmental, social and economic costs, which do not translate into costs for power producers and consumers.

Government decisions with regard to energy policies, but also consumer decisions, have an impact in terms of costs that future society and future generations will have to pay to offset the effects.

One of the biggest externalities associated to the use of fossil fuels to produce energy is air pollution, which translates into premature deaths.

Over 5.5 million people a year die because of air pollution in the world

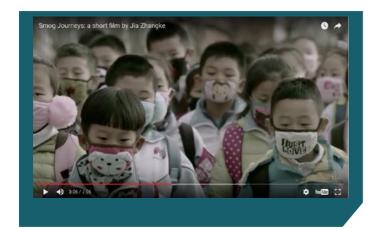


Every year more than 5.5 million people die in the world because of air pollution and more than half of these deaths occur in two of the fastest growing economies: China and India. These data resulted from an international study performed by the Global Burden of Disease, which analysed health and risk factors, including air pollution, in 188 Countries between 1990 and 2013. According to this study, air pollution causes more deaths than malnutrition, obesity, alcohol and drug abuse and unprotected sex.

The main causes of death are power plants, industrial production, vehicle emissions, coal and wood heating, which release harmful particles for human health.



Cardiovascular diseases account for most deaths caused by air pollution, which has an impact also on lung cancer, chronic obstructive pulmonary diseases and respiratory infections.



In the next 25 years, the Asian continent will be the hardest hit, with 90% of the world's premature deaths. The main problem is that the growth of energy demand in India and in South-East Asia makes the emissions reduction planned by industrialised countries so far completely ineffective.

In China, the biggest cause of premature deaths is coal combustion, which caused at least 366,000 deaths in 2013, equal to the entire Bologna population. It is estimated that in 2030 air pollution will cause between 990,000 and 1.3 million premature deaths unless China approves much more ambitious air emission reduction goals.

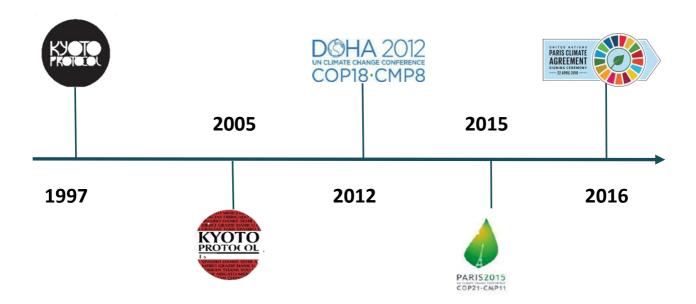
According to the International Energy Agency, the world should do more to replace fossil fuels with clean sources of energy. According to the Agency's annual report, premature deaths caused by air pollution will grow to 4.5 million from the current 3 million by 2040.

More decisive policies should consider banning biomass stoves, imposing stricter and more controlled standards for road vehicle emissions, more energy efficiency in industries and clean sources of energy. These measures would bring down premature deaths to 2.8 million with regard to external pollution and to 1.3 million with regard to home pollution.



INTERNATIONAL AGREEMENTS ON CLIMATE

The main international agreement on climate is the **United Nations Framework Convention on Climate Changes (UNFCCC)**, one of the three conventions adopted at Rio's Earth Summit in 1992. It has been ratified by 195 nations so far. It is a tool that allows Countries to cooperate to contain global warming and climate changes and to face consequences.



Several agreements have been signed based on the 1992 Framework Convention, including:

The Kyoto Protocol

In the mid 90s, signatories of the UNFCCC understood that stricter measures were needed to cut emissions. In 1997, they approved the Kyoto Protocol, which introduced legally binding emission reduction goals for developed Countries. The Kyoto Protocol entered into force on 16th February 2005.

Kyoto second commitment period started on 1st January 2013 and it will end in 2020. 38 developed countries, including the European Union and its 28 member states, joined it. In this period, known as the **Doha amendment**, participating Countries undertook to **cut emissions by at least 18% compared to 1990 levels**. The European Union committed to a 20% emissions reduction compared to 1990 levels.

The main problem with the Kyoto Protocol is that it asks only developed countries to take measures. Considering that the United States have never joined the Protocol, that Canada withdrew before the end of the first period and that Russia, Japan and New Zealand did not join the second period, this tool currently applies only to about 14% of global emissions. However, 70 developing and developed countries have taken several non-binding commitments to reduce or contain emissions of greenhouse gases.



Paris Agreement

The Paris Agreement was adopted on 12th December 2015 during COP21, the Twenty-first Conference of the Parties on Climate Change. It is the first global agreement that provides for greenhouse gas mitigation measures, adaptation to climate change and economic implications. It will enter into force in 2020.

The long-term objective of the Agreement is **keeping average global warming well under 2°C** above pre-industrial levels and continue efforts to reduce it to 1.5°C.

Governments decided to update their plans every five years to set more ambitious goals and accepted to communicate their results to ensure transparency and control.

The European Union and the other developed countries will continue to provide developing countries with financial resources to help them reduce emissions and become more resilient to climate impacts.

The Paris Agreement is the result of negotiations started in Durban in 2011. It was adopted as an annex to a COP Decision containing several suggestions and provisions and was preceded by almost two hundred individual national commitments.

On April 22nd 2016, the Earth Day, 175 Countries signed the Paris Agreement on Climate Change and on the same day, 15 Countries deposited their instruments of ratification with the United Nations.

After the ceremony held on April 22nd, two more States signed the Agreement, thus bringing the total to 177 Countries (including the European Union). At least 34 Countries, accounting for 49% of greenhouse gas emissions, have ratified it or stated that they would by 2016. Italy will ratify the Paris Agreement in 2016.

Countries at war, very poor Countries and oil-producers, accounting for 5.6% of emissions, have not signed the Paris Agreement yet. The Agreement has been signed by Countries accounting for 94.41% of the total greenhouse gas emissions.





DIVEST AND INVEST

The Divest-Invest movement started in 2011 at some US universities, where a campaign was launched to divest from fossil fuels at college campuses. Initially students were asking universities to divest from fossil fuels, focusing on the moral principle that universities could not support or draw a profit from industries that harm the environment.

It was immediately clear that the economic aspect would play a major role: fossil fuels investments are volatile in the short term and potentially very risky in the long term.

Investors have begun to believe that when markets incorporate climate risks in their projections, the so-called "carbon bubble" will burst. The financial sector is becoming aware of this factor. The increased focus on this issue has led to the creation of the Divest Invest movement, supported by several international institutions. The objective of the campaign is to encourage investors and portfolio managers to divest from fossil fuels over the next five years and to re-invest, at least partially, in renewable energy, clean technologies and energy efficiency.



More than 500 institution all over the world have committed to some form of divestment from fossil fuels, including pension funds, foundations, universities, religious organizations and local authorities.

A coalition of philanthropic foundations, including Rockefeller's heirs, Leonardo di Caprio and Prince Charles, have begun to divest from fossil fuels, as well as other major cities such as San Francisco, Seattle and Oslo. The largest sovereign wealth fund in the world, Norway's Government Pension Fund (Global GPFG), divested from 114 companies for climate-related reasons, including from oil sand manufacturers. Several insurance companies including Axa and Allianz, banks such as HSBC and the World Bank and over 2 thousand individuals have promised to divest from fossil fuels, totalling a commitment to divest of 3.4 trillion dollars.

What does divesting from fossil fuels mean?

Divesting is the opposite of investing, it means selling assets. The global Divest Invest movement is asking institutions to take their money away from oil, coal and gas companies for moral and financial reasons.



Why divesting?

Almost all arguments in favour of divesting from fossil fuels are linked to moral and financial reasons.

The moral question is supported by data. Scientific research shows that in order to meet the 2°C global warming limit to prevent climate catastrophes, between 2/3 and 4/5 of the fossil fuels currently available should be left in the soil. From a financial standpoint, the reason is that if the international community takes steps against climate change, investment in fossil fuels will lose value.

Is our money invested in fossil fuels?

Almost certainly. Most banks have invested millions of euros in companies operating in the fossil fuels sector. Most investment funds, including billionaire pension funds, have largely invested in fossil fuels and do not offer any fossil free options, even though demand is increasing.



ENERGY EFFICIENCY

The biggest energy innovation is to do without energy

The cheapest and cleanest energy choice is not to waste it. Impressive improvements have been made, but potentials are still enormous. Since 1970, energy efficiency has improved in the 11 IEA members (United States, Australia, Great Britain, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands and Sweden).

According to the Agency, energy efficiency improvements since 1990 in member Countries made it possible to avoid 870 million tons of CO_2 in 2014 and a total of 10 billion tons in the last 25 years, more or less equal to current annual emissions of IEA member Countries.

Big economic resources have been invested to achieve better results: **in 2012, between 310 and 360 billion dollars were allocated to energy efficiency measures**, equal to investments in renewable energy and higher than investments in electricity generation from fossil fuels.

Energy efficiency is the most effective tool to reduce carbon emissions generated by the energy sector, which account for over 40% of the reductions required to limit global warming to 2°C above pre-industrial levels. New results clearly indicate that improvements in this area can really turn back the clock on carbon emissions.

The energy that was not consumed in 2014 thanks to investment in energy efficiency over the last 25 years has made it possible for IEA member Countries to save 550 billion dollars, more than the amount spent by the European Union on fuels import.

The "fifth fuel", as **energy efficiency** is sometimes called, **is in fact the cheapest.** A report issued by the American Council For Energy Efficiency Economy (ACEEE) estimated that the average cost to save a kwh is 2.8 cents, while the cost of a kwh for the end user in the United States is 10 cents.

Italy is among the most efficient Countries in the world

According to ACEEE annual report, which has analysed energy consumption and rationalization in the world's 16 largest economies, Italy ranks second in terms of energy efficiency. The 16 Countries analysed in the 1994 ACEEE report generate 81% of the world's GDP and account for 71% of global energy consumption. Germany is first; Italy is followed by the European Union, China and France.



SUSTAINABLE MOBILITY

There are more than 1 billion cars in the world and only 0.1% (one million) is electric.

2040 projections show 41 million electric cars sold (35% of the total number of new cars sold), which means that $\frac{1}{4}$ of cars on the road will be electric.

In the meantime, in 2016 in Norway more electric, hybrid and hybrid-electric cars than diesel or petrol cars were bought, and France is working to increase the number of charging stations. Germany, where there is a wide offer of green cars, wants to reach one million electric cars by 2020 and is implementing a 2-2.5 billion euro plan to promote sustainable mobility. China is becoming the first world market for zero emission vehicles, overtaking the United States. To meet the needs of an increasing number of electric cars, Italy announced that it will increase the number of charging stations in the next two years. At the same time, FCA (Fiat) has signed an agreement with Google to develop 100 prototypes of driverless cars. This type of car will lower consumption and emissions because it will eliminate bad driving behaviours.

These data help us imagine the future of the automotive industry in the next 20 years, with major impacts on the entire energy system.



If the projected development of electric cars materializes, in 2040 the 13 million barrels of oil per day used by cars will be replaced with 2,700 TWh of electric power.

If those 2,700 TWh are generated by renewable sources, it is good news. Otherwise, the only effect will be to displace emissions from urban areas to the areas where electricity is produced.

It is an important factor, considering air pollution in urban areas, which causes millions of premature deaths each year, but certainly not sufficient to reach the greenhouse gas reduction objectives set by the Paris Agreement to keep global warming below the 2°C increase compared to pre-industrial levels.



Increasingly cheaper electric cars

According to analysts of Bloomberg New Energy Finance (Bnef), by 2022, considering the purchase price and operating costs, it will be more cost-effective to own an electric car than a conventional one. The key will be plummeting battery costs.



Today, despite subsidies in several Countries, and even though battery costs are 65% lower than in 2010, electric vehicles are more expensive than conventional cars. But the positive forecasts are based on a further drop in battery costs by 2030 and on technology development.



GREEN JOBS

Renewable sources and energy efficiency are not limited to low environmental impact energy generation and consumption; they are also synonymous with "green economy" and "green jobs".

Numbers are clear: according to Irena (International Renewables Energy Agency), the renewable energy employment reached **8.3 million jobs in 2015**. The Countries with the highest number of people employed in this field are: **China**, **Brazil**, **United States**, **India**, **Germany**, **Spain** and **Bangladesh**.

EurObserv'ER data show that in 2014 more than a million people in Europe worked in the renewable sources sector. Italy, with 82,500 people employed in renewables-related jobs, ranks fourth among European Union Countries. Germany is first (347,400), followed by France (169,630) and Great Britain (92,850).



Looking at the entire green economy sector and not just at jobs strictly linked to the energy sector, according to the sixth report issued by Fondazione Symbola and Unioncamere, "GreenItaly 2015", over 3 million people are employed in the green sector. The most requested professional profiles are low-impact heating systems installers, energy engineers, mechatronic technicians, ecobrand managers, green purchasing manager, demolition expert focusing on materials recovery, urban restoration expert, sustainability-minded window fitters, recycled products marketing experts, agriculture and forestry planners, pedology experts, environmental engineers, environmental statisticians and risk managers.



These are continually evolving professional profiles that should be able to respond to the development of new technologies and regulatory evolution.

The need for new professional profiles implies demand for training; this is the reason why new educational paths linked to sustainability are being developed by universities and schools, with work-related learning projects to train new sustainability professionals.

In the energy sector, many dedicated vocational schools, degree courses and postgraduate courses are being created, focusing on the energy manager, from energy generation to consumption. The offer is wide. What matters is reliability of the training provider.