GrEAT
Green Education for Active Talents

INTELLECTUAL OUTPUT 2
TRAINING MODULES AND MATERIALS

Renewable energies

Co-funded by the Erasmus+ programme of the European Union.

INDEX

1. RENEWABLE ENERGIES

1.1. European Energy Sector

Energy is a strategic sector because we cannot do without it. It is vital for lighting, protecting against the cold and transporting people and goods, and it also underpins all the sectors of the economy — agriculture, industry and services — as well as scientific progress. Our standard of living requires huge amounts of energy, and that obviously generates pollution (air, water, soil and climate) whose impact needs to be reduced as much as possible.

Europe is consuming, and importing, increasing quantities of energy. EU countries are well aware of the advantages of coordinated action in this highly strategic field. This has led to common rules throughout Europe and a pooling of Europe's efforts to secure the energy that it needs at an affordable price, while generating the least possible pollution.

1.2. The world's larger importer

Europe depends on the rest of the world for its energy. The European Union, the world's second largest economy, consumes one fifth of the world's energy, but has very few reserves of its own. Fortunately, here in Europe, our portfolio — known as the energy mix — is very diverse: from Austria's many dams, Poland's coal mines and France's nuclear power stations to the oil rigs of the North Sea and the gas fields of Denmark and the Netherlands, none of Europe's countries are alike, and that is not a disadvantage. Provided, of course, that those countries work together to make the most of their diversity.

Europe's energy dependence has an enormous impact on our economy. We buy our oil from the Organisation of Petroleum Exporting Countries (OPEC) and Russia, and our gas from Algeria, Norway and Russia. Europe's coffers are depleted to the tune of over €350 billion every year to pay for it. Energy costs are also constantly on the increase. That leaves us with no other option: EU countries have to be efficient, set ambitious goals and work together if they are to diversify their energy sources and supply channels.

1.3. Climate constrains

Leading experts have demonstrated what the exorbitant cost of climate change will be if the world does not succeed in reducing its greenhouse gas emissions. The energy sector is directly involved here as over 80 % of its output comes from fossil fuels, which emit carbon dioxide (CO2), the main greenhouse gas, when they are burnt. In the future, therefore, the European energy sector will have to cut down on fossil fuels and make much more use of low-carbon energy sources.

1.4. Renewable energies as part of solution

Renewable energy is at the core of Europe's long-term energy strategy because it helps to reduce greenhouse gas emissions and reduces Europe's energy imports, making Europe more independent. This booming economic sector contributes to European technological leadership, providing EU countries and their regions with new 'green' jobs and high added-value exports.

The current EU objective is for 20 % of the energy consumed in the European Union in 2020 to come from renewable sources (and at least 27 % by 2030). Promotion of this objective throughout Europe has led to a spectacular increase in the production capacity of renewable energy sources. In 2011 over 100 gigawatts of solar panels were installed worldwide, 70 % of them in the EU. EU renewables production contributes to reducing fossil fuel imports equivalent to around €400 billion every year.

Europe's expanding renewable energy market has considerably reduced the cost of renewable technologies: the cost of solar panels has for instance fallen by 70 % over the last 7 years.

Renewable energy is also part of a growing 'green' technology sector which employs more and more people in Europe. In 2011, 1.2 million people had renewable-energy-related jobs. By 2020, the renewables and energy efficiency sector are expected to employ over 4 million people across the EU.

1.5. Main sources of renewable energy

Renewable energy resources are from sources of energy that replenish or renew themselves naturally. Renewable energy resources include the following:

Wind Energy

The kinetic energy of the wind is converted into electricity by using wind turbines. Turbines can be located either on land or offshore. The amount of power generated varies with wind speed, which can make power supply difficult to predict over short time periods.

Wind energy as a renewable energy resource accounted for almost 13% of total primary energy production of renewable energy in EU-28 in 2015.

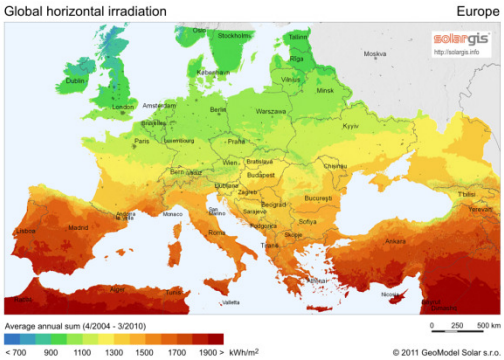
Solar Energy

Solar energy is a renewable energy resource. Around 6% of total primary energy production of renewable energy in the EU-28 in 2015 was generated by this means. The most common example of electricity and heat generation from the sun are:

- Conversion of solar energy into electricity by using a photovoltaic cell
- Concentration of energy from the sun's rays to heat a receiver. This solar heat is transformed into mechanical energy by turbines and thus into electricity available for consumption
- Generation of heat energy through solar thermal technologies

The generation of electricity and heat by means of solar energy has the following main features:

- Solar energy is an infinite resource and freely available;
- Large areas of land are required to capture the sun's energy with collectors;
- the generation depends on the level of insolation, which varies between different regions and weather conditions;
- Solar energy can be used in remote areas where the electricity power grid is not available; and
- More and more everyday appliances can be operated with solar energy.



Hydropower

In 2015, hydropower was Europe's largest renewable energy resource accounting for more than 14% of total primary energy production of renewable energy in the EU-28.

Hydropower is generated by first converting the potential energy stored in water into the kinetic energy of running water, which is then converted into electrical energy via turbines.

The main hydropower technologies are:

- run-of-river hydropower plants - obtain energy for electricity production from river water;
- reservoir hydropower plants – use water stored in a reservoir for electricity production; and
- pumped storage plants – here, water is pumped from a lower reservoir into an upper reservoir when electricity supply tops demand.

Where there is reservoir storage of water, hydropower can be generated when needed to meet rapid or unexpected fluctuations in demand. However, there are limited possibilities for sites and potentially high environmental impacts through land use and conversion.

Energy from Biomass

Biomass - organic material of non-fossil origin, including organic waste - can be converted into bioenergy through combustion, either directly or via derived products. Around 64% of total primary energy production of renewable energy in the EU-28 in 2015 is generated this way.

Examples of derived products from waste streams include the conversion of waste oil into biodiesel, animal manure and organic household waste into biogas and plant or plant waste products into

biofuel. The following materials can be used in the generation of bioenergy:

- Wood and wood waste;
- The organic part of municipal solid waste;
- The organic part of industrial waste;
- Sewage;
- Manure;
- Crop plants and plant by-products of food production.

Along with the rain and snow, sunlight causes plants to grow. The organic matter that makes up those plants is known as biomass. Biomass can be used to produce electricity, transportation fuels, or chemicals. The use of biomass for any of these purposes is called biomass energy.

Biomass, particularly woody biomass, can be directly combusted to generate heat and/or electricity.

Biogas, primarily methane and carbon dioxide, is produced through the bacterial decomposition of organic matter like sewage, manure, organic household waste and plant crops.

Biofuels are liquid fuels from a non-fossil biological origin and also represent a renewable energy resource. Biofuels can be divided into biogasoline and biodiesel depending on the material of origin used.

Since the organic plant matter has absorbed carbon dioxide as it grows, when it is finally burnt to generate bioenergy it releases a comparable amount of carbon back into the atmosphere.

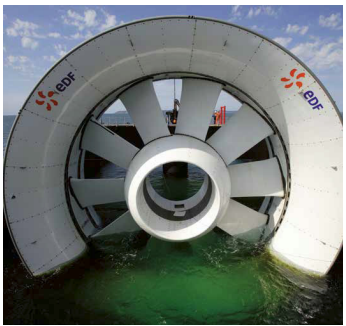
However, agricultural biofuel production is in potential competition with agricultural food production. According the Helmholtz Centre for Environmental Research (UFZ), bioenergy crop production is rapidly increasing in the EU, and in 2011 used 13% of Europe's agricultural land. The land demand of bioenergy crops can be contentious and needs to be balanced in the context of an overall sustainable approach to land management.

Geothermal

In 2015, geothermal energy contributed to around 3% of total primary production of renewable energy in the EU-28 countries.

Geothermal energy is present in the earth in the form of heat, and stored in rocks, trapped vapour, water or brines. This heat energy can be used directly for heating or to generate electricity.

A major advantage of geothermal energy lies in the reliability of its supply as well as its nearly unlimited availability. However, the technological system (pipe system) can require large amounts of space, and there are difficulties in maintaining the equipment which is mainly based deep under the earth's surface. Additionally, there can be adverse environmental impacts through the release of potentially harmful or hazardous substances as a side product of this kind of energy production.



According to the International Energy Agency (IEA) geothermal energy could account for around 3.5% of annual global electricity

production and 3.9% of energy for heat (excluding ground source heat pumps) by 2050.

Tidal, Wave and Ocean Energy

Tidal, wave and ocean energy currently makes only a minor contribution to electricity production, both in the EU countries and worldwide. In 2015, this energy source contributed 0.02% of the total electricity generated from renewable energy sources in the EU-28.

Since the 1970s there have been a variety of technologies under development to exploit different sources of energy in the oceans, however, none of the different types of technologies are widely applied yet with France and UK being the only countries in the EU-28 which report primary energy production generated by this source in 2015.

Tidal, wave and ocean energy sources include:

- Tidal energy: the potential energy in tides due to their rise and fall can be harnessed by building a barrage or other forms of construction across an estuary;
- Tidal (marine) currents: the kinetic energy associated with tidal currents can be harnessed using modular systems;
- Wave energy: the kinetic and potential energy associated with ocean waves can be harnessed by a range of technologies under development;
- Temperature gradients: the temperature gradient between the sea surface and deep water can be harnessed using different ocean thermal energy conversion (OTEC) processes;
- Salinity gradients: at the mouth of rivers, where freshwater mixes with saltwater, energy can be harnessed using the pressure-retarded reverse osmosis process and associated conversion technologies.

1.6. EU renewable energies evolution

Renewable energy sources include wind power, solar power (thermal, photovoltaic and concentrated), hydro power, tidal power, geothermal energy, biofuels and the renewable part of waste.

The use of renewable energy has many potential benefits, including a reduction in greenhouse gas emissions, the diversification of energy supplies and a reduced dependency on fossil fuel markets (in particular, oil and gas). The growth of renewable energy sources may also have the potential to stimulate employment in the EU, through the creation of jobs in new ‘green’ technologies.

Renewable energy in the EU has grown strongly in recent years. More concretely, the share of energy from renewable sources in gross final energy consumption has almost doubled in the last years, from around 8.5 % in 2004 up to 17.0 % in 2016.

This positive development has been prompted by the legally binding targets for increasing the share of energy from renewable sources enacted by Directive 2009/28/EC on the promotion of the use of energy from renewable sources. While the EU as a whole is on course to meet its 2020 targets, some Member States will need to make additional efforts to meet their obligations as regards the two main targets: the overall share of energy from renewable sources in the gross final energy consumption and the specific share of energy from renewable sources in transport.

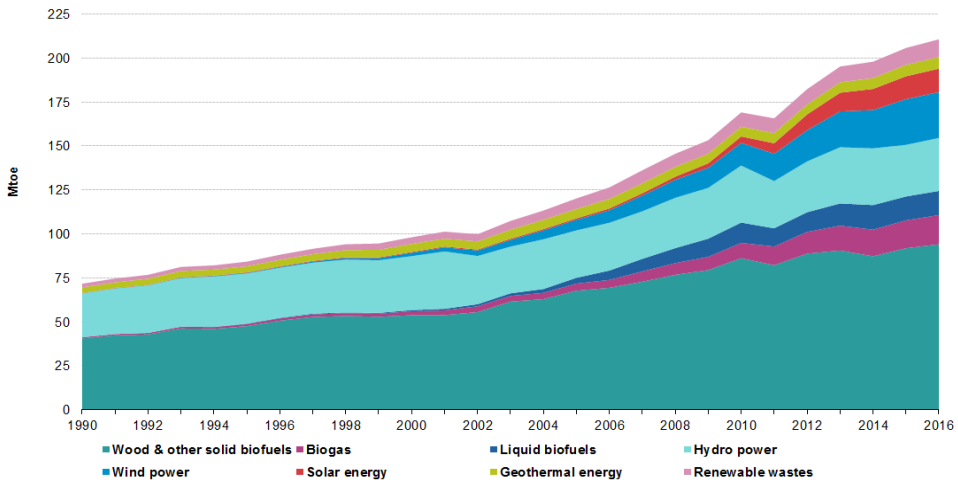


Figure 1. Primary production of energy from renewable sources EU-28 1990-2016 (Source: Eurostat)

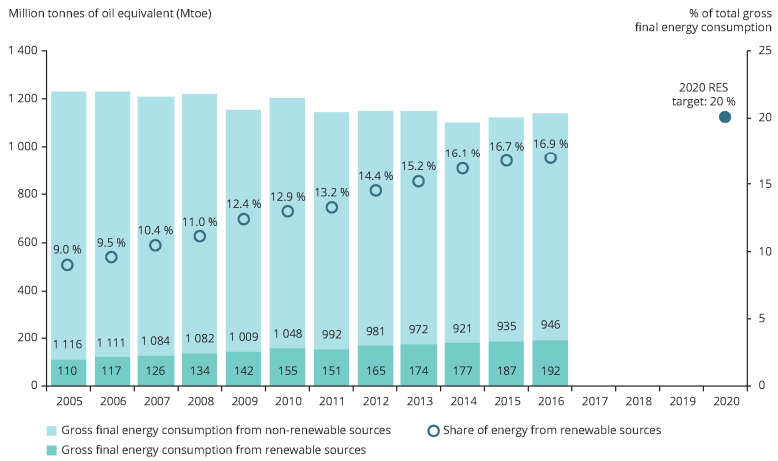


Figure 2. Gross final energy consumption of renewable energy and non-renewable energy sources, 2005-2015 and approximated RES share 2016. (Source European Environment Agency)

1.7. Estimated effects of RES consumption

In 2015, the additional consumption of renewable energy, compared with the level of gross final RES consumption in 2005, allowed the EU to:

- Reduce total GHG emissions by 447 $MtCO_2$ equivalent to 9% of the total EU GHG emissions;
- Cut its demand for fossil fuels by 135 Mtoe, or roughly 10% of the gross inland consumption of fossil fuels at the EU level;
- Reduce its primary consumption by 36 Mtoe, equivalent to a 2% reduction in primary energy consumption across the EU.

2. REFERENCE LAW

Article 194 of the Treaty on the Functioning of the European Union: EU energy policy is aimed at promoting the development of new and renewable forms of energy to better align and integrate climate change goals into the new market design.

A. Initial steps

Following the 1997 White Paper on renewable energy sources (COM(1997) 0599), the EU set itself targets of using renewable energy sources (RES) to meet 12% of energy consumption and 22.1% of electricity consumption needs by 2010, with indicative targets for each Member State set out in Directive 2001/77/EC. The lack of progress towards achieving the 2010 targets led to the adoption of a more comprehensive legislative framework.

B. Renewable Energy Directive

The existing Renewable Energy Directive, adopted by codecision on 23 April 2009 (Directive 2009/28/EC, repealing Directives 2001/77/EC and 2003/30/EC), established that a mandatory 20% share of EU energy consumption must come from RES by 2020. In addition, all Member States are required to obtain 10% of their transport fuels from RES by 2020. The directive also mapped out various mechanisms that Member States can apply in order to reach their targets (support schemes, guarantees of origin, joint projects, cooperation between Member States and third countries), as well as sustainability criteria for biofuels.

The directive specifies national renewable energy targets for each country, taking into account its starting point and overall potential for renewables. These targets range from a low of 10% in Malta to a high of 49% in Sweden. EU countries set out how they plan to meet these targets and the general roadmap for their renewable energy policy in national renewable energy action plans. Progress towards the national targets is measured every two years when EU countries publish national renewable energy progress reports.

C. Future steps

On 30 November 2016, the Commission published a legislative package entitled 'Clean energy for all Europeans' (COM(2016) 0860) as part of the broader Energy Union strategy (COM(2015) 0080). It includes a proposal for a revised Renewable Energy Directive (COM(2016) 0767) to make the EU a global leader in RES and to ensure that the target of at least a 27% share of renewables in the total amount of energy consumed in the EU by 2030 is met. The Commission's proposal for a new directive also promotes the use of energy from RES and aims at acting in six different areas:

- Further deploying renewables in the electricity sector;
- Mainstreaming renewables in the heating and cooling sector;
- Decarbonising and diversifying the transport sector (with a renewables target for 2030 of at least 14% of total energy consumption in transport);
- Empowering and informing customers;
- Strengthening the EU sustainability criteria for bioenergy;
- Making sure the EU-level binding target is achieved on time and in a cost effective way

To know better all regulations and legislation on support schemes, grid issues and policies for energy from renewable sources in each European country you can look on http://www.res-legal.eu/

Renewable energies regulation in SPAIN

The renewable energies regulation in Spain does not begin to develop until the 1980s, with a law tha encourages mini-hydroelectricity (law 82/1980 on energy conservation) in order to face the oil crisis and improve energy efficiency, thus reducing dependence on the outside. Already en the following decade, the National Energy Plan 1991-2000 encourages production with renewable energy and, through Law 40/1994 of the national electricity system, the concept of special regime is consolidated. Thus, Royal Decree 2366/1994 on the production of electricity by hydraulic installations, cogeneration and others supplied by renewable resources or sources, regulates the electric power of the special regime. By virtue of this Royal Decree, the nearest distribution company has the obligation to acquire the surplus energy of these facilities whenever it is technically feasible. The sale price of energy is fixed based on electricity rates, depending on the installed power and the type of installation, consisting of a power term and an energy term, in addition to other complements.

Since then, they have been modified on many occasions, mainly in order to regulate the technical characteristics of the facilities, as well as defining the types of facilities and rewards or bonuses of the energy generated by these, with the main purpose of promoting their development.

In January 2012, in order to undertake the resolution of the high tariff deficit of the electricity system, Royal Decree-Law 1/2012 was approved, by which the economic incentives for projects aimed at the installation of new electric power production plants through renewable sources, cogeneration and waste were suspended.

Currently, Royal Decree 900/2015 is in force, regulating the production facilities with self-consumption. Controversial and feared royal decree that taxes the self-consumption facilities and that involves the application of access tolls (named colloquially as "sun taxes").

On the other hand, the Technical Buiding Code (CTE), is the regulatory framework tha establishes the requirements tha buildings must meet in relation to the basic requirements of the safety and habitability established in Law 38/1999. Within this, limitation of energy consumption, limitation of energy demand, performance of thermal installations, energy efficiency of lighting installation, minimum solar contribution of sanitary hot water and minimum photovoltaic contribution of electric energy is established.

Renewable energies regulation in ITALY

The energy market is articulated in manifold needs and requirements for the efficient functioning of the national productive sector and for the well-being of the Country as a whole. After the starting phase, deeply rooted in hydro-electric industry in Northern Italy, from the 1950es the whole sector have been nationalized and a monopoly have been built in the hands of a National State-owned Company (ENEL). In the new framework of increasing competition and market openness introduced by the strengthening process of both globalization and European integration, in 1992 the national energy market inaugurated a new course of liberalization, with the transformation of the same ENEL in a private company, the free entrance of other energy producers and the end of public monopoly on the sector in all segments of energy production and distribution. In 1997 the new system was completed with the establishment of a National Authority for Energy and Gas (AEEG), in charge of the tasks of control, sanction, setting of tariffs, promotion of the competition in the energy market.

In the same years, the Italian system have seen an increasing role for renewable energy, as witnessed by the 37% coverage of installed power and by the 31% coverage of total gross production. Even though this is due to the deep tradition in hydro-energy, since 2000 solar-photovoltaic, biomass and wind energy consumption are increasing, reaching the relevant result

of 17,4% of total energy consumption and overcoming the European Union average (17%). The obligation for energy producers and importers to introduce in the energy system from 2% to almost 4% of renewable energy, supported the development of renewable segments. In 1999 operators have been allowed to comply the obligation even indirectly, i.e. purchasing in the market the quotas of renewable energy from authorized producers, who guarantee the fulfilment of the rule by selling dedicated bonds (the so called Green certificates) on a parallel "non-energy market".

From a normative point of view, the main legislative source for renewable energy in Italy is the European Union, that in 2009 enacted Directive 2009/28/EC setting compulsory targets for the coverage of total energy consumptions with renewable energy for State members. The directive (accepted by Italian Government with Decree no. 28/2011) assigns to Italy the following objectives to 2020: 17% of total gross energy consumption covered by renewable energy (complied); 10% of total gross energy consumption in transports sector covered by renewable energy. To enforce the normative acts, the Italian Government implemented since 2010 a National Action Plan for renewable energy (PAN), that describes tools, trajectories and previsions to increase the relevance of renewable energy in the Italian sector.

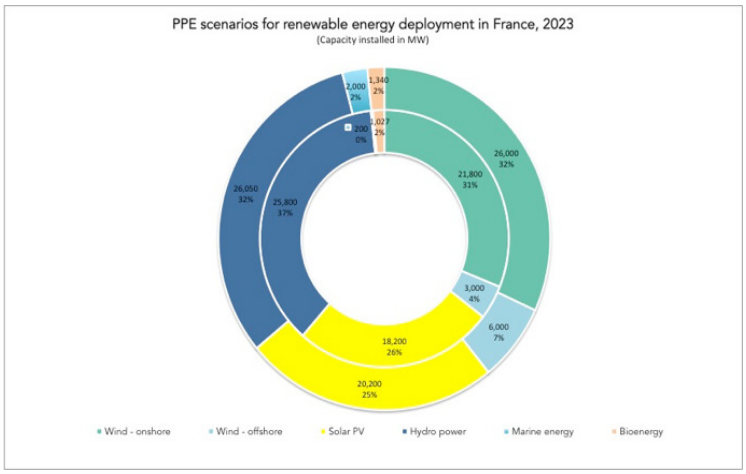
Besides of the Renewable energy issue, since 2006 European Union focuses on the energy efficiency issue. This is the matter of Directive 2006/32/EC, enacted in Italy with Decree no. 115/2008 and implemented through the National Plan on Energy Efficiency (PAEE). The latter is a document, nowadays at the third version, drawn by the National Agency for Energy and Environment (ENEA) that sets objectives for energy saving (-10% with respect to 2006 consumptions).

In addition, in 2013 Italian Government approved the National Energy Strategy (SEN), aimed at reducing energy costs, complying and overcoming all EU targets for energy and environmental issues, increasing energy provision safety and developing the national energy production sector. As a matter of fact, SEN set the objective of a 35-28% of energy consumption covered by renewables, making of them the first source of energy production in Italy.

Renewable energies regulation in FRANCE

The French National Renewable Energy Action Plan (NREAP) was commissioned by the Directive 2009/28/EC which required Member States of the European Union to notify the European Commission with a road map. The report describes how France planned to achieve its legally binding target of a 23% share of energy from renewable sources in gross final consumption of energy by 2020.

The expected total energy consumption in 2020 is 155,268 ktoe and hence the amount of energy from renewable sources in 2020 should be 35,711 ktoe. The National Renewable Energy Action Plan sets a target of the share of renewable energies to be 27% in electricity sector, 33% in heating/cooling sector and 10,5% in transport sector by 2020.



Grenelle de l'Environnement

1 (2007) and 2 (2010) are the basis for the action plan. France focuses on comprehensive improvement of energy efficiency and the use of all renewable energies will be increased. Each administrative division of the country has to compile a plan, SRACE (Schéma Régional du Climat, de l'Air et de L'Energie), with both qualitative and quantitative targets for the use of renewable energies. In addition, PPI (Programmation pluriannuelle des investissements de production d'electricité et de chaleur) is a plan to strengthen the energy sector and reach the targets set. One target in France is also to simplify the administrative processes and increase the amount of bidding processes related to renewable energies.

Wind energy: Each SRCAE (Schéma Régional du Climat, de l'Air et de L'Energie) include regional wind energy plan with potential locations for onshore and offshore production. Overall target for wind energy in France by 2020 is 25 000 MW (onshore 19 000 MW, offshore 6 000 MW). National energy company EDF or other energy company is obliged to buy the produced wind power from the specific locations for wind power (ZDE).

Feed-in tariffs in France for wind power are following: (first 10 years) onshore 0,082 €/kWh, offshore 0,13 €/kWh (after 10 years) onshore 0,028 – 0,082 €/kWh, offshore 0,03 – 0,13 €/kWh.

Solar energy**:** Target for solar energy is 5% (5400 MW) of renewable energies by 2020. Solar energy tariffs are based on markets and the size of the system. Unique feature in France is to prefer integrated solar energy systems with higher tariffs

Bioenergy: According to Grenelle 2, 50% of renewable energy targets will be achieved bybiomass. Feed-in tariffs for bioenergy (only over 5 MW CHP-plants): 0,045 €/kWh for electricity, 0,08-0,13 €/kWh bonus according to efficiency and resource use of the plant. No tariff for produced heat

Under the EU Directive 2009/28/EC member countries of the European Union are obliged to draft and submit to the European Commission National Renewable Action Plans (NREAPs) outlining pathway which will allow them to meet their 2020 renewable energy, energy efficiency and GHG cuts targets.

France 2020 renewable energy targets:

- Overall target: 23% of share of energy generated from renewable sources in gross final energy consumption;
- Heating and cooling: 33% of heat consumption met by renewable sources;
- Electricity: 27% of electricity demand met by electricity generated from renewable energy sources;
- Transport: 10.5% of energy demand met by renewable energy sources.

In order to achieve above enlisted targets France runs following incentive schemes:

- Modifications of administrative procedures in order to overcome administrative barriers to the deployment of renewable energies;
- Tax reliefs (VAT, Measures improving energy efficiency and energy savings in buildings;
- Grants Financial aid to research, development and deployment of renewable and energy efficiency technologies;
- Investments in railway infrastructure with purpose of energy savings.

Every two years, each Member State has to submit a report in the promotion and use of energy from renewable sources. These progress reports assess the situation of each member states regarding their national objectives.

Renewable energies regulation in CROATIA

Croatia, as a member of the European Union, has pledged to accept the European Climate Energy Package, which also includes Directive 2009/28 / EC about promotion of the use of renewable energy sources. By adopting the Directive, Croatia has assumed an obligation to increase the use of renewable energy sources; the share of energy from renewable sources in gross consumption in 2020 shall be at least 20%, observed at EU level.

In the Republic of Croatia (on January 30th, 2015) were installed 1,070 renewable energy plants (OIE) and the total installed power of these plants was 412,594 MW. Compared to the last report (from the end of September 2014), it is visible the increase for 65 power plants with total power of 47,044 MW. Thus, in total power system there is one wind power plant, 62 solar power plants, one hydro power plant, one biogas plant more.

3. MAIN POLICY INSTRUMENTS

The European Union has the powers and instruments that it needs to implement an energy policy geared towards:

- securing Europe's energy supply;
- ensuring that energy prices do not make Europe less competitive;
- protecting the environment and in particular combating climate change;
- improving energy grids.

EU countries are free to develop whatever energy sources they wish. They must, however, take account of EU renewable energy objectives.

Europe's expanding renewable energy market has considerably reduced the cost of renewable technologies: the cost of solar panels has for instance fallen by 70 % over the last 7 years.

Renewable energy is at the core of Europe's long-term energy strategy because it helps to reduce greenhouse gas emissions and reduces Europe's energy imports, making Europe more independent. This booming economic sector contributes to European technological leadership, providing EU countries and their regions with new 'green' jobs and high added-value exports.

3.1 EU Energy Targets

The EU has set itself energy and climate targets for 2020, 2030 and 2050.

Targets for 2020:

- Reducing greenhouse gases by at least 20% compared to 1990 levels
- 20% of energy from renewable sources
- 20% energy efficiency improvement

The EU's Renewable energy directive sets a binding target of 20% final energy consumption from renewable sources by 2020. To achieve this, EU countries have committed to reaching their own national renewables targets ranging from 10% in Malta to 49% in Sweden. They are also each required to have at least 10% of their transport fuels come from renewable sources by 2020.

All EU countries have adopted national renewable energy action plans showing what actions they intend to take to meet their renewables targets. These plans include sectorial targets for electricity, heating and cooling, and transport; planned policy measures; the different mix of renewables technologies they expect to employ; and the planned use of cooperation mechanisms.

Targets for 2030:

- 40% reduction in greenhouse gas emissions
- At least 27% EU energy from renewables
- Increase energy efficiency by 27-30%
- 15% electricity interconnection (i.e. 15% of electricity generated in the EU can be transported to other EU countries)

Renewables will continue to play a key role in helping the EU meet its energy needs beyond 2020. EU countries have already agreed on a new renewable energy target of at least 27% of final energy consumption in the EU as a whole by 2030 as part of the EU's energy and climate goals for 2030.

On 30 November 2016, the Commission published a proposal for a revised Renewable Energy Directive to make the EU a global leader in renewable energy and ensure that the 2030 target is met.

Target for 2050:

An 80-95% cut in greenhouse gases compared with 1990 levels. The Energy Roadmap 2050 shows how we could do this.

3.2 Support schemes for renewables

Public interventions such as support schemes remain necessary to make certain renewable energy technologies competitive. To avoid distorting energy prices and the market however, these schemes should be time-limited and carefully designed. The EU has issued guidance on support schemes to help governments when they design or revise support schemes.

4. JOB MARKET

Renewable energy is also part of a growing 'green' technology sector which employs more and more people in Europe.

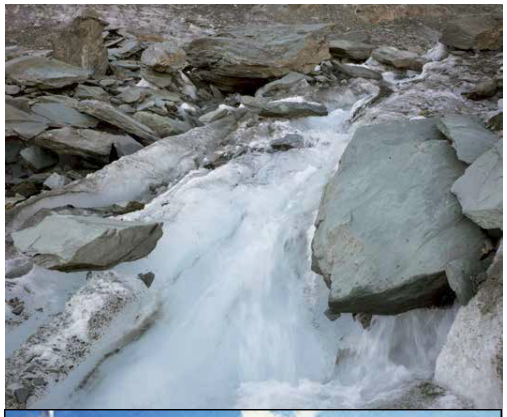
According to the Eurobserver 2017 study, the renewable energy market offers the following employment data:

WIND POWER: Wind power sector remains an important contributor to the EU-wide socioeconomic figures. While *turnover amounts to an estimated € 39.3 billion in 2016* (a decrease of € 1 billion from the 2015 estimate of € 40.3 billion), EurObserv'ER estimates the resulting employment at 309000 jobs for the same year, considering 3 main activities: investments in new installations, operation and maintenance activities for existing and newly installed turbines, and the production and trading of renewable energy equipment.

PHOTOVOLTAICS: The European Union continues to lose ground in the international PV sector. In 2016, the annually connected capacity contracted by 22.7% compared to 2015. The British market's lower connection figures are largely responsible for this decline but more generally, European markets are in the throes of a transition phase that aims to introduce new renewable electricity production support mechanisms. The latter are outlined by the new European Commission guidelines set out in 2014, to promote greater integration of renewable energies into the electricity system by subjecting them to market-based regulation. These changes mainly hit the development of medium and high capacity power plants that form the mainstay of European growth. Overall, The European PV industry in 2016 still represented a € 10.7 billion market (compared to € 12.7 billion in 2016) and a workforce of 95900 employees (down from 113400 in 2015).

SOLAR THERMAL AND CONCENTRATED SOLAR POWER: Since 2009, the European Union's solar thermal market has been contracting by an annual average of 6.9%. For 2016, the solar termal segment dedicated to heat production (domestic hot water and space heating) contracted by a further 4.6% in 2016 down to 2.6 million m2, a figure far away from the peak reached in 2008 with more than 4.6 million m2. The solar thermal market is directly hit by the low price of oil and natural gas and the stop-start,

declining subsidy policies in place in several European countries. To compensate the under-performing individual home segment, the sector is pinning its hopes on the development of the collective solar segment that includes industrial solar heat and solar district heating. Total solar thermal employment in the European Union is estimated at 29000 jobs in 2016 (30900 in 2015, -6%) and turnover was found to have gone down approximately 1% (from € 3.45 billion in 2015 to € 3.4 billion in 2016).



HYDROPOWER: EurObserv'ER reports a 2016 labor situation at around 75900 jobs, down from an estimated 94800 jobs in 2015. For turnover, the trend is similar with a decrease from 9.5 to € 8.6 billion. These results are mainly driven by a decline observed in installation capacities, for large as well as small hydro plants, in most of the European Union Member States. Although most suitable hydropower sites are already utilized and new constructions being hindered by numerous regulation constraints or environmental obstacles, a minimum activity level is maintained with the repowering of the oldest plants.

GEOTHERMAL ENERGY: Geothermal energy is a renewable source that for many years was mainly developed in a few European countries, with Italy as a frontrunner for electricity generation and accompanied by France for heat production. However, over the past few years the picture moved and other Member States have been picking up this technology, reason for which currently Hungary, Germany, Romania, Slovakia, the Netherlands, Bulgaria and Poland are standing out in geothermal energy statistics, mainly opting for geothermal heat production. Electricity generation remains a technology for the countries with the best geologic geothermal potentials, i.e. Italy, Portugal, Germany, France and Austria.

With an estimated 8600 jobs in 2016, deep geothermal energy is, in terms of employment and turnover, the smallest sector amid all renewable technologies developed in the European Union. Its activity trend was decreasing in 2016 with a significant jobs reduction (12200 in 2015) and a turnover also downward oriented, from € 1400 to 950 million between 2015 and 2016. The largest share of economic activity and employment is based on the operation and maintenance part of the existing power plants and heat generating facilities.

BIOGAS: In 2016, European Union primary energy production from biogas continued its upward trend (growing by 3 % to 16.1 Mtoe) although the pace has been on a steady decline since 2011. The main reasons for this decline are regulations hostile to the use of energy crops that initially boosted output in those countries that decided to develop farm biogas (primarily Germany, Italy and the UK) and the setting of less attractive financial terms for biogas electricity. On the back of this downward trend, investment in new plants also slowed down over the past few years which impacted employment and turnover. So the estimated overall total EU employment decreased from 83700 jobs in 2015 to 76300 in 2016 (-9%). The estimated turnover decreased from € 8.7 to 7.6 billion (-12%).

BIOFUELS: The European Union's biofuel consumption has flattened out after increasing steadily from the early 2000s until 2012. In 2016, biofuel consumption in the transport sector slightly increased by 1.3% compared to 2015 and EurObserv'ER estimated the consumption at 14.4 million toe. Biodiesel still accounts for roughly 80% of overall European biofuel consumption. Based on this situation, EurObserv'ER assumes that the European Union cumulative biofuels workforce increased from 2015 (178200 jobs) to 2016 (205100 jobs). Estimated biofuels turnover went up to € 13.1 billion (2016) from € 11.7 billion (2015).

RENEWABLE MUNICIPAL WASTE: According to the accounting rules of the Renewable Energy Directive, the biomass share contained in municipal waste and incinerated in Waste-to-Energy (WtE) plants is considered to contribute to the renewable energy share. The amount of total primary energy production in the EU (electricity and heat) from Renewable Municipal Waste (RMW) increased from 9397 ktoe in 2015 to 9698 ktoe in 2016. France, Germany, Italy, Sweden, and the Netherlands are major energy producing countries using renewable municipal waste.

In line with the new methodology, job impact is assessed through three activity areas: investment activities, operation and maintenance activities and fuel-related activities. The figures are also dependent on the volume of thermally treated waste in a country. However, the job impacts from the collection and transport of waste are not incorporated in the approach.

EurObserv'ER estimates around 25000 labor forces in the European Union, and a turnover involved slightly above € 3 billion.

SOLID BIOMASS: Solid biomass is an umbrella term for all solid organic components to be used as fuel. It includes wood, wood chips, timber industry by-products (off-cuts, sawdust, etc.) black liquor from the paper industry, wood pellets, straw, bagasse and other solid plant residues that cater to the needs of biomass use for heating and electricity production in the residential, commercial, industrial and energy sector.

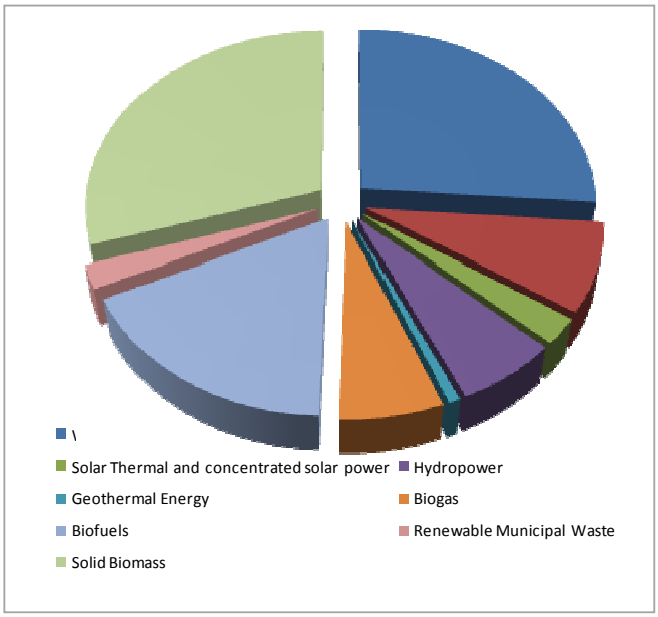
Solid biomass turns out to be the largest renewable energy sector in the EU in terms of jobs. EurObserv'ER arrives at a slightly increased (2%) head count of over 352.500 jobs (346 100 in 2015) and a growing EU wide industry turnover of over € 31.9 billion. The most important players are located in the markets with the highest shares of biomass in terms of installed generating capacity. Moreover, a number of European Member States are pursuing policies to substitute part of their coal consumption by solid biomass.

The following tables and graphs show a summary of employment of renewable energies.

Table 1. Renewable energies employment

	EU 28	Croatia	France	Italy	Spain
Wind Power	309.000	1.400	18.800	9.400	22.000
Photovoltaic	95.900	<100	5.200	10.700	2.200
Solar Thermal and Concentrated Solar Power	29.000	100	1.100	1.400	8.000
Hydropower	75.900	1.600	10.200	13.400	10.900
Geothermal Energy	8.600	<100	600	2.300	<100
Biogas	76.300	600	1.800	8.000	1.300
Biofuels	205.100	1.900	33.200	6.500	15.100
Renewable Municipal Waste	25.700	<100	4.000	3.800	700
Solid Biomass	352.500	15000	35.400	32.600	18.400
TOTAL	**1.178.000**	**20.600**	**110.300**	**88.100**	**78.600**

Figure 3. Renewable energy employment by sector EU28 - 2016



5. PROFESSIONALS

A key challenge to the renewable energy industry will be to align education and training to meet the emerging skill needs of both new and existing occupations and industries.

Job creation and the subsequent skills implications associated with EU climate action rely on significant increases and shifts in investments. Market and policy uncertainties, as well as the potential for localised spikes in demand, can cause challenges for education and training systems. In particular, time-lags between initial training and the eventual work placement mean that decisions on the design of education and training often need to be made in advance of market needs to support renewable industries.

In some parts of the sector, an entire job role may be related to renewable energy. Here, the occupational profile may be shaped by particular technologies, requiring technical skills related to development, construction and operation. Although some of these skills may be new or unique, many will be similar to skills already existing outside the sector.

In particular, 'new' and priority skills related to innovation may be needed, such as problem-solving, design and working with stakeholders.

Emerging occupations have been identified relating to the manufacture of renewable equipment (e.g. wind power design engineers), project development (e.g. wind resource assessment specialists), and production and operation (e.g. wind service mechatronics technicians; biomass production managers).

In other areas, and across all countries, renewables may form an additional aspect to an existing job. In the construction sector, for example, the small-scale installation of renewable technologies is often carried out by those working in dual roles as roofers, electricians or plumbers, who also install renewable technologies. Specialisms have emerged in the area of solar energy for small photovoltaic, large photovoltaic, solar thermal and concentrated solar installations. In terms of wind energy, there is a need for specialist small wind turbine installers.

In order to expand renewable energy capacity, investment to reinforce and upgrade workers' skills is needed. Key skills include the need to develop and maintain awareness of the regulatory environment, management and teamwork skills to engage with other trades; as well as communication and marketing skills to engage with customers and sell their services.

In the majority of cases, extensive reskilling is not required. Instead, the focus is on upgrading certain skills through structured education and training; especially science, technology, engineering and maths skills and the broad range of technical and managerial skills needed to adapt to new technologies. A commitment to training is particularly important because the renewable energy sector is already experiencing shortages not only in technical occupations such as solar installers and geothermal engineers, but also in more general occupations, such as sales and finance specialists, inspectors, auditors and lawyers.

5.1 Photovoltaic Energy Project Designer

Activity description

The efficiency of any solar power system depends on two critical aspects – Good design and quality components. A high yielding solar power plant always starts with a good design.

In most solar EPC/installation companies, design team is a critical element and hence most companies prefer to have an in-house design engineer.

A Solar PV Designer's job is mainly to design and develop site plans for solar panel installation. The Design Engineer takes the initial system concept ideas and translates them into fully detailed construction ready designs. Coordinating with multiple team members and customers, the Design Engineer balances the necessity of a customer solution with the efficiency of standard practices.

Competences

Depending on the specific position and role, your job will involve some or all of the following:

- Use custom software tools to design PV ground mounted and roof top systems
- Perform accurate system sizing calculations
- Create electrical single-line diagrams, panel schedules, or connection diagrams for solar electric systems, using computer-aided design (CAD)/ PVsyst software

- Run PVsyst reports for system production estimates
- Develop optimal designs with single line diagrams, conduit and wire scheduling, routing and equipment plans, and conceptual 3-D renderings

- Execute designs that adhere to grid compliance and permitting requirements
- Building detailed bills of materials based on system specifications
- Coordinates with management team to develop complete proposal packages
- Work across functionally with sales, project management and installation teams to ensure clients' needs and internal deadlines are met

- Troubleshoot design and construction issues in the field

Reference job market and economical treatment

The occupations involved in this stage of the value chain reflect the diverse range of activities carried out. Most of the employment is at high skill levels, with some medium skill level support staff. Occupations include (among others) engineers of various disciplines for design work, professions relevant to site assessment, professions relevant to gaining approval such as lobbyists, mediators and land use negotiators, and the financial occupations needed to plan and obtain finance. Skills in environmental assessment may also be important.

The economical treatment of PV energy project designer depend on the country, knowledge, experience, manager abilities, responsibilities and people in your charge, and may vary from 1500 euro/month to 4000 euro/month.

Course of study

Most of the employment is at high skills lever, with some medium skill level support staff. That is why, university engineering degrees are required, and with any job experience also is demanded some Master or additional post degree course of renewable energies.

Summary

The Design Engineer takes the initial system concept ideas and translates them into fully detailed construction ready designs. Coordinating with multiple team members and customers, the Project Engineer balances the necessity of a customer solution with the efficiency of standard practices.

To know more

- Study of occupational and skill needs in renewable energy: final report / International Labour Office, ILO Skills and Employability Department (EMP /SKILLS). – Geneva: ILO , 2011
- Photovoltaic Geographical Information System

http://re.jrc.ec.europa.eu/pvg_tools/en/tools.html

- Solar Power Europe (European Photovoltaic Industry Association)

http://www.solarpowereurope.org/home/

5.2 Construction Manager of Wind Energy Farm

Activity Description

A project may be well conceived and adequately financed, the resources may be specialists, and consultants may be highly experienced, but if the efforts of all the participants are not skillfully coordinated and managed, the project may overrun the budget, fail to meet the schedule, or fall short in functional and technical quality. The larger and more complex the project, the more critical this overall management function becomes.

Construction managers are held responsible for the overall success of the project. They are responsible for managing the interaction between all stakeholder groups, civil works, electricians, mechanics, engine drivers…, most of them subcontracted, each of whom have their own expectations and project success criteria. The construction manager is often well served by putting their egos aside and keeping a necessary emotional distance from their work. Summarized, the position of project manager demands an overall defined skill set and personality profile.

Competences

All great construction projects require the efforts of countless skilled workers, hundreds of specific tasks, and the leadership of a great construction project manager.

However, inexperienced construction managers have the potential and technical knowledge for greatness, but they must possess five crucial abilities to become a “Great Construction Project Manager”.

- Communicate clearly and effectively to others involved in a project.
- Delegate tasks to those capable of completing them, or assign workers to oversee areas of a project.
- Evaluate progression and adherence to deadlines on a routine basis. When something changes, you may need to re-prioritize your planned activities and tasks.
- Develop problem solving skills by considering potential problems faced in a project. Come up with solutions to problems that others have not considered.
- Create an environment of teamwork and willingness to help coworkers.

References job market and economical treatment

Wind power sector remains an important contributor to the EU-wide socioeconomic figures, with a turnover estimated of € 39.3 billion and 309000 jobs. This sector has reason to stay optimistic.

The high growth scenario published by WindPower – the European Wind Energy Association – of 366000 by 2030 based on ambitious post 2020 renewable policies is still reach.

Depending on the knowledge, experience, size of the wind farm, responsibility and country, a construction manager can have a salary ranging from 1500 to 5000 euro/month.

Course of study

To work as a construction manager is needed high degree studies. The main professional level skills are in civil, mechanical and electrical engineers, and it is usually demanded high experience for wind farms.

A construction manager of wind farms is an engineer responsible for directing the material execution of the work and for qualitatively and quantitatively controlling the construction. They have to manage all stakeholders, usually subcontracted, involved in the execution of the work, for which is needed, among others, communication skills, problem solving and leadership skills.

To know more

- EWEA – the European Wind Energy Association
- WindEurope
- Study of occupational and skill needs in renewable energy: final report/International Labour Office, ILO Skills and Employability Department (EMP/SKILLS). – Geneva: ILO , 2011

5.3 Technician – Installer of Renewable Energies Systems

Activity Description

The main activity of the technician – Installer is the physical and real execution of the installation according to the specifications of the project and the instructions of the project manager.

Depending on the type of renewable energy installations can be electricians, civil workers, plumbers, welders and instrumentation and control technicians.

Competences

The main competences needed to become a good installer are a good knowledge of the technology and characteristics of the installation that is needed to do (mainly civil, mechanical and electrician works), problems solving, drawing interpretation, organization of work, tools and machinery management, safety …

In recent years is also important to cover the existing gap of installers with high knowledge about renewable energies technologies.

References job market and economical treatment

This chapter explains the technician-installer in general for all types of renewable energies installation. Electricians and civil workers are usually in all type of renewable energy installations, and depending on the installation it is also needed plumbers, welders and instrumentation technicians among others.

The technician-installers has a very huge job market thinking on the relevance of the renewable energy sector in Europe, representing around 1.4 million persons (included direct and indirect jobs).

The economical treatment for installer can range between 1000 and 2500 euro/month, depending on the specialization, experience and risks.

Course of study

The studies needed to become a general technician-installer are Vocation Education and Training level in the interested sector (electrician, civil worker, plumber, instrumentation…). For technician/installers of renewable energy systems it is high recommended to have an specific technical high school or middle school of renewable energies.

5.4 Designer/ R&D Technician of Renewable Energy Systems

Activity Description

Designer/R&D technician is the person responsible of the design and development a new product or component, creating or investigating solutions for new products that are innovative, practical, and suitable for manufacturing.

R&D engineers from mechanical, electrical, software, physics, chemistry, material science, systems design, process engineering and other backgrounds are involved in developing new products or components for renewable energy systems.

Competences

Designers are involved in the making of products, and their responsibilities include:

- High knowledge on renewable energies technologies
- Consulting managers and clients about design requirements
- Negotiating and agreeing contracts, budgets and time-scales
- Clarifying and solving design issues
- Investigating appropriate materials and production processes
- Producing sketches and sample designs
- Testing product designs using models, prototypes, specialist computer software and computer-aided design (CAD) technology

- Maintaining an awareness of current design trends and influences
- Liaising with sales, marketing and production departments
- Correcting product faults
- Presenting designs, samples and final work to customers for evaluation

References job market and economical treatment

The main job opportunities are offered by manufacturers of different parts or components of each renewable energy system. These can manufacturers of metal, electrical and electronic components, and in most cases can be technical consultancy company or research institutes or universities which develop new design or products.

The economical treatment is highly variable, ranging between 1500 to 3500 euro/month.

Course of study

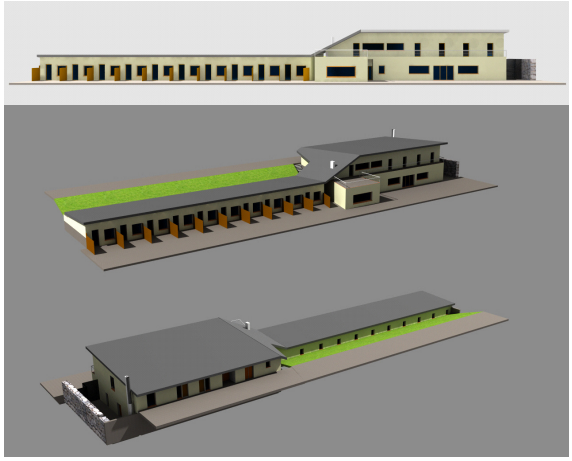
To work on design or R&D department to develop new products of renewable energies systems are needed a high university degree. Depending on the component to be designed, engineering of different specialties, physics, and chemistry may be required.

6. CASE STUDIES / EXPERIENCES

6.1 Self-Sufficient Rural Hotel Mar De Fulles

The Mar de Fulles project is a brand new ecotourism concept, which describes itself as a Sustainable Eco-Management Network. It consists of a bioclimatic touristic complex located next to the nature park of Sierra de Espadán (Castelló, Spain) and a wild bird special protection area managed by Natura 2000. This pioneering and innovative project brings together ecology, sustainability and energy efficiency at a level never before seen in Spain. The construction of the complex respects in its entirety the surrounding forest and follows the strictest possible criteria for environmental integration.

The complex is made up of:



1. A hotel with ten 30m^2 bedrooms that have 20m^2 terraces.
2. A hostel: five rooms for 8 occupants with a terrace.
3. A 2000 m^2 private garden in front of the terraces.
4. A panoramic swimming pool.
5. 30 conditioned woodland spaces.
6. 5 conditioned group spaces in the forest.
7. Parking.
8. A restaurant with an indoor dining room for 60 to 150 diners and an outdoor dining space for more than 150 diners.
9. Multipurpose rooms.
10. A reception with tourist information and guidance.
11. An ecological food garden.

Principal characteristics of the complex:

- Bioclimatic construction.
- PVC free.
- Energy self-sufficient.
- Integrated landscaping.
- Integrated water management.
- Integrated waste management.
- Woodland management.
- Ecological agriculture.

The main characteristic related to this chapter is its energy self-sufficiently, without connection to the electricity grid. The tourist complex has an isolated photovoltaic installation that generates all the energy necessary for its operation.

The system will make complete energy autonomy possible, generated purely from clean, renewable sources.

The photovoltaic installation has a peak power of 51.85 kW, and it is composed of 170 photovoltaic modules of 305 W each one, 5 battery chargers, 120 acid-lead batteries to store energy produced and 11 inverters to convert direct current to alternating current.

The installation can generate 75.400 kWh per year, representing an estimated consumption of more than 20 households.

The photovoltaic installation was financed by crowdlending. Crowlending allows companies to finance themselves through a large and diverse group of people without having to go a bank. In the crowlending model people lend small amounts of money to a company in exchange for a financial return stipulated in a loan agreement.

The project and photovoltaic installation won the 2016 Project of the year of Citizen Energy, the first European platform to encourage cross-border investment in sustainable energy.

6.2 Austrian Biomass district heatings

Biomass in the form of wood is considered the oldest form of energy in the world. However, the use of biomass in automatic wood furnaces and heating plants has a relatively short history. The first biomass-heating plants and district heating grids in Austria were established around 1980 by the initiative of sawmill operators in order to use the by-products from their sawmills.

Ever since the 1980s Austria has taken a leading role internationally in the construction and development of biomass heating plants and heating grids. Efficient biomass heating plants and heating grids do not only make an important contribution to climate protection, but also enhance investments and create green jobs. This sustainable and independent energy supply provides economic benefit which strengthens and adds value to regional development.

The construction of new plants boomed through the initiative of agricultural and forestry holdings and cooperatives and proved the viability and functionality of this technology. Consequently, the interests of economy, science and politics significantly increased. Due to the new surge in energy and environmental consciousness and the arising climate mitigation efforts the advantages of a biomass heating plant were quickly recognized:

- Regional
- Renewable
- CO_2 neutral

The growing technological demand led to the foundation of new enterprises and a fast technological advancement of the combustion technology and systems engineering due to

increased research activities and newly established research institutes. The result was among others the development of automatically fed biomass-small heating plants and its market launch.

Driven by the increase in oil prices and the enforcement of climate protection regulations due to the Kyoto-protocol, numerous biomass district heating plants have been built in Austria as of the turn of the millennium.

Currently there are more than 2,000 biomass district heating plants in Austria that produce about 4,600 GWh renewable heat. In addition, there are more than 100 active biomass cogeneration plants that produce both heat and power which is then fed into the district heating grid to supply industrial companies (e.g. drying chambers, pellets production, etc.).

New biomass district heating plants are still built and existing heating plants and heating grids are constantly being enlarged in Austria by gaining new heat customers and expanding net lines.

The Austrian bio-energy success story created many new enterprises in the promising bio-energy sector that successfully promote their products and services in Austria but especially on the international market. Moreover, the erection and the operation of new biomass heating plants create value and jobs in the region. In 2013 a primary total turnover of about 2.4 billion €, created 18,000 jobs and reduced the dependency on energy imports. The specific research competencies built up in Austria and the existing technical and practical know-how in the sectors bio-energy and renewable energy guarantee a sustainable development of the bioenergy sector in Austria.

Biomass district heating plants and heating grids are important infrastructure projects with long-term focus that strengthen rural areas as a space for working and living. Moreover, they are promotionally effective for municipalities and especially for tourism areas concerning climate protection measures.

Biomass district heating plants guarantee the income for farmers and foresters through the supply of biomass fuel and the operation of heating plants.

Moreover, the supply of low-cost and renewable heat can enhance the foundation of new enterprises e.g. drying of agricultural products.

Biomass district heating plants serve as a model example and a flagship for energy transition. They promote energy consciousness of the local population by local events or guided tours through the heating plants. Biomass district heating plants can thus become the starting point for new projects in the sector energy efficiency and renewable energy in the region.

6.3. Som Energia. Renewable Energies Cooperative

Som Energia is a Spanish renewable energies cooperative that was officially founded in December 2010 in Girona, making it the first of its kind in Spain.

All started when Huijink, one of the founders, buy an old farm in Spain in 2005 and realize how difficult was to get electricity there. At first he studied installing solar panels and batteries. After, he thought about putting a small wind turbine next to their house. But then he run into the legislation, the economic and practical procedures and everything started to get complicated. After a while, he realized that it would be much simpler to invest in a larger wind turbine with other people. He started looking for a cooperative in Spain but they could not find one, so they decided to create one. He shared the idea with her friends and several were quickly interested.

In December 2010, 157 people came together with the common goal or producing and consuming their own renewable energy. In January 2011, they started requesting all the necessary permits and in October they opened the service, initially for a few hundred clients.

Finally, a first 100 kW PV project in an industrial building in Lleida was selected. The installation began in early 2012 and by April it was fully operational. Another 8 projects were selected and carried out, giving way to a plant of 732 kWp of solar energy and a biogas plant of 500 kW. The total investment amounted to 3.5 million euros. Around 1,100 of their members participated. The collection of money started in June 2012 and in 10 months they had already been fully financed. All these investments kept them very busy until the beginning of 2014. At that time there were less than 10 people in the office to carry out all the tasks. Then, the Government of Spain decided that it had produced more than enough renewable projects and could not afford to pay more food tariffs (FIT), so no more projects would be accepted, paralyzing the development of new advances.

The project also began in the midst of a financial crisis. There was no access to bank financing of any kind. The banks were simply closed. They were trying to manage existing businesses and reduce their losses and they were not interested in new business, and less in a cooperative without any financial experience or any number behind. However, due to all these barriers, they quickly realized that nobody was going to make it work, they had to do it. They could not count on any support, and therefore, they concentrated and planned a strategy.

They found their own model. With a mix of solar, wind and hydroelectric projects throughout Spain, they tried to simulate the typical demand curve of tits members as best as possible. Since there were no Feed-In Tariffs, all the projects had to complete in 'market' and even pay a 7% electricity production tax to the State. Only the most efficient projects guaranteed the profitability of the investments, so they looked for projects in the south of Spain with 1,600 hours of total load, in places with a lot of wind with more than 2,700 hours of total load and re-feeding of hydroelectric projects where the public works were in good condition and 'only' they had to install a new turbine.

Nowadays, Som Energia is a renewable energies cooperative with over 47,000 members, which can participate by making a special 25 years loan without interest to the cooperative. They invest in the system and not in a specific technology. Everyone shares the advantages and disadvantages of each project. For each participation of 100 euros, participants receive around 170 - 200 kWh / per year as compensation in their electricity bill with Som Energia.

In May 2017, the cooperative had over 47,000 members, 76,500 clients, had invested over 15 million euro in renewable energy production projects, had produced over 9,922,296 kWh, employed 60 people and expects to bill 50 million euros during 2018.

Som Energia is a cooperative that produce, transports, distributes and markets green electricity with the investments made by its members.

7. TRACKS FOR ACTIVITIES IN CLASS

7.1 Creating a Solar-Powered Machine or Model

The idea

The idea of this activity is that the students learn, by the method "learning by doing", about the main different solar power systems existing and analyze different uses of solar energy.

Learning objectives

The main objectives of the laboratory are:

- Learning about solar potential energy
- Learning about different solar systems and their use
- Improving researching skills
- Learning teamwork

Who is the target

Students of high-school

Work tracks and realization

Review and discuss on solar energy technologies. Assign a several week-long project of designing and creating a working solar-power apparatus of model. Students may work in groups or independently to develop and present their creations to class. Choices for projects may include the following:

- Concentrated solar collector for cooking
- Small model of solar water heater with heat transferred from collector to water container to an output

- A model demonstrating solar thermal electricity (with collector and rotating object representing a turbine)

- A model of working PV cell devise (small PV cells can be obtained through internet)

When the students complete the solar-power projects will present it to class, explaining the system, how it works, the benefits…

It is a good option to invite a solar energy specialist for a class presentation.

7.2 Make your own solar car

The idea

The idea is to learn about photovoltaic solar energy and how can be used for power a miniature car.

Learning objectives

- Learning about solar energy by doing a miniature car.
- Teamwork skills
- Manual skills

Who is the target

Students

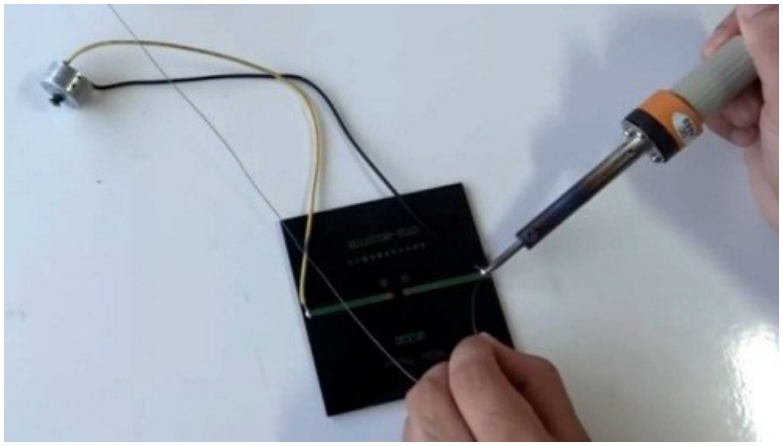
Work tracks and realization

In this activity it will need creativity and experimentation to design and build a car powered by two solar cells and a small electric motor.

1. Materials to be used: 01 small plastic bottle, 02 sticks for skewers, 01 solar panel of 10x10cm of 5 or 6 volts, 04 plastic soda lids, 01 silicone gun, 01 silicone bar, 01 bad CD player that does not work, 01 cuter, scissors.

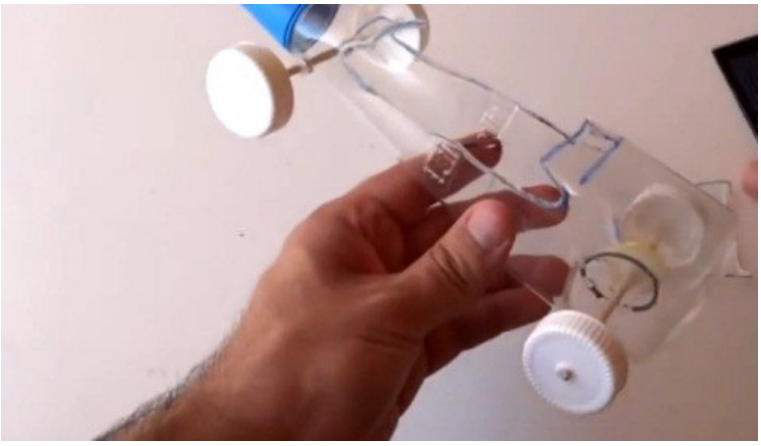
2. Remove the motor, drive belt and gears from the CD drive to build the transmission system used in the car.
3. Generally CD players have three engines (the one that moves the tray, the one that rotates the CD and the one of the head). We will focus on the tray motor as it brings the drive belt and the gear.

4. Once the motor, transmission belt and gear are removed, we weld two cables that go from the motor input terminals to the output terminals of the solar panel.

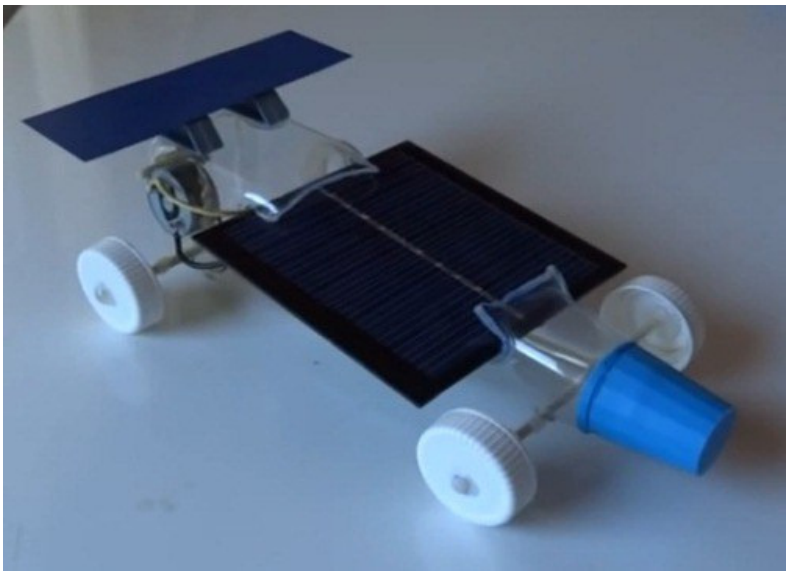


5. With a pair of scissors we cut the chopsticks to an approximate length of 10 cm (to serve as axes of the bearing system).
6. Now, with the soldering iron, perforations are made in the center of the soda lids.
7. Four perforations are made in the bottle two in the front and two in the back. Perfectly aligned where the axes of the bearing system of our car will pass.
8. Two silicone stops are placed and one of the axes is installed. This way the front end will be ready.
9. For the construction of the rear axe, one of the covers will be placed on the transmission shaft and the gear previously removed from the CD reader that will work as a pulley will be fixed.

10. Then the transmission belt is placed and the rear axe is installed taking into account that it must be placed parallel and very close to one of the sides of the car and perfectly perpendicular to the axle.



11. Finally we make a hole in the bottle using the soldering iron, where by pressure we will fix the motor and install the transmitter belt to the motor shaft and ready we will have finished our homemade solar toy car.



8. BLIBLIOGRAPHY AND SITOGRAPHY

The European Union Explained. Energy. Sustainable, secure and affordable energy for Europeans. European Commission. Directorate-General for Communication. ISBM 978-92-79-42192-1

The State of Renewable Energies in Europe. Edition 2017. 17th EurObserv'ER Report.

Renewable Energy and Jobs. Annual Review 2017. IRENA International Renewable Energy Agency.

Renewable Energy Prospects for the European Union. 2018 –European Union and IRENA. ISBM 978-92-9260-007-5.