SUSTRAINY
Sustainable action Training for Youth

Co-funded by the Erasmus+ Programme of the European Union

SUSTRAINY PROJECT

ENVIRONMENTAL

TOPIC N°4 GREEN TECHNOLOGIES

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Introduction to the topic

Climate is a factor that changed along the years and throughout the history. The current warming trends are of a particular significance as a result of human activity that has increased the carbon-dioxide emissions since the mid-20th century, which contributed to the greenhouse effects. The consequence is the increase of temperature, which has devastating effects on nature such as the destruction of massive territories of barrier reefs and changed the animals' territories. It also affects humans activity. Nowadays migrations are not only result of social and economic issues anymore. There is the emergence of a new kind of migrations: environmental migrants. Climate change is affecting the living and natural patterns, Arctic and Antarctic is melting and sea level is rising. The strength of storms is increasing and rainfalls are suffering changes and producing devastating effects.

Among the issues that have been discussed in relation to this are green technologies, which covers all technologies that are used without harming the environment. In this sense, alternative and renewable energies have been on the focus of many conversations. The use of fossil fuels and performance of illicit practices are damaging the nature and planet's living systems. There is a need to proceed with the transition and replace fossil fuels with renewable energies like solar, hydropower, geothermal, biomass and wind. Renewable energy or alternative energy are the ones that can be constantly renewed by natural means and coming from natural sources or processes, produced from sources that do not deplete, and with much lighter environmental footprint than fossil fuels. In addition, shift and investment in low carbon or zero emissions transport solution need to be implemented as starting point (Greenpeace, 2020).

There are also many political and societal movements that have been born as a consequence of the current situation. The Green New Deal, a congressional resolution to tackle climate change, aims to establish a system and build a society in which the energy will be generated 100% thought renewables and clean energies. The resolution aims to change the electrical system, invest in R&D on energy and change the transports infrastructure, among others (Friedman, 2019). At European level, the renewable energy directive (2018/2001/EU) establishes the policy for the promotion and production of renewable energy in the EU. The directive entered into force in December 2018 as part of the Clean energy for all Europeans package, aimed to help EU emission reduction commitments under the Paris Agreement and keeping the EU as the leader in renewables. The directive establishes the EU renewable energy target for 2030 to fulfil at least 32% of the total energy needs with renewables.

Furthermore, European countries establish their own energy national action plans, complying with the European directive but adapted to their particular available resources and energy markets. The individual national action plans cover topics such as the choice of the individual renewable energy targets and measures to ensure that biofuels used meet renewable energy targets, among others (European Union, 2020).

The society is currently facing an entrance in the Fourth Industrial Revolution, distinguished for the interconnection of physical and virtual systems, and the possibility of global connection and cooperation. Green Technologies have an important say in this change, and they can become one of the main positive outcomes of this revolution, as technological improvements can in turn facilitate the encouragement and invention of new ways to assure the protection of the environment while improving the society's living conditions.

But there are also other interesting initiatives related to Green Technologies which are being developed worldwide. Ideas such as the Society 5.0., an initiative held in Japan to promove a more technological society, aiming to create a social reform in which all members of the society have the opportunity to lead an enjoyable life. This concrete initiative has been born due to the problems of population aging, which in turn will become a challenge for the Japaneses economy.

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Chapter 1 – Green renewable and alternative energies

1.1 Renewable and alternative energies – Concept

Wood has been the major source of energy of all the nations' until the mid-1800s. From the late 1800s until nowadays, fossil fuels such as coal, natural gas and petroleum have been predominant. Regarding the renewable energy source methods, the hydropower and solid biomass were the energy sources most used until the 1900s. Since then, the consumption and production of energy through renewable energies experimented an increase with new sources such as solar, wind or biofuels.

Source: Renewable Energy Sources (All Activity, 2016)

In 1896, for the first time, a Swedish scientist named Svante Arrhenius tallked about the negative effects of fossil fuel and its contribution to the global warming. Nowadays, the climate situation is a severe issue with negative prognostics, and it is creating a general shift towards environmental awareness and the source of climate change, making the citizens aware of the situation. Different organizations and governments are supporting the shift, considering that renewable energies bring lower emissions, lower fuel prices and the reduction of pollution compared to fossil fuels. However, even being an alternative to traditional energy sources, it does not mean it is completely environmentally safe, because in occasions, for instance, it might have environmental impacts in an indirect form or as a result of the needed manufacturing processes (IRENA, 2019).

Renewable energy is taken from parts of the planet's physical structure, renewed by natural means; it is obtained throughout existing flows of energy and natural processes.

The sustainable energy sources are also called ''alternative energies'', as they present alternatives to the traditional fossil fuels.The renewable energy sources are part of the group of alternative energy sources, but not all alternative energy sources are renewable. Alternative sources include all the non-fossil based processes and sources. Alternative, not renewable sources are for instance, fission power and hydrogen power. Renewable energy sources are those naturally occurring and replenishing naturally, without humans' interaction.

Even if these energies have been existing for years, they have been requiring a sophisticated technology to exploit them at a commercial level. The investment in energy research and development experienced an increase by the oil crises of the 1970s and accelerated since then, with an increase of 1000% of the consumption. Developing nations produce and consume more renewable energy compared to industrialized or transitioning countries. European countries have been the fastest growing countries in renewable energy usage due to support for the expansion of renewable energy sources.

1.2 Sustainable Energy Sources

Sustainable energy sources are those derived from natural resources that are not finite or exhaustible. It is the alternative to traditional energy, fossil fuels, being less harmful and more sustainable forms of energy. The several renewable energy sources are the following:

Source: (Shekhani, 2014)

- Bioenergy – Bioenergy is used to define the energy generated from organic matter. It can be classified into traditional and modern bioenergy. The traditional bioenergy is the one obtained from the biomass that can be taken from plants, timber, animal waste and traditional charcoal. Biomass can be directly burned for power generation or heating, or converted into oil or gas substitutes, being liquid biofuels, a renewable substitute for gasoline. The modern bioenergy technologies include liquid biofuel, bio-refineries and wood pallet heating systems, among others. Bioenergy can be used in heating, electricity, transport and cooling; and as mentioned previously it can be used in a solid form, such as burning wood for energy, liquid forms, like the biofuels and gaseous forms, like biogas. Bioenergy emits carbon dioxide emissions, and the overall environmental impact and benefits of bioenergy depends on whether energy crops or waste feedstock are being used (Good Energy, 2019).

- Geothermal – Geothermal energy takes its origin within the sub-surface of the earth carried by water and/or steam to the Earth's surface, usually located to nearby tectonically active regions. Regarding the usage of this type of energy, it depends on it characteristics. It can be used for cooling and heating purposes or be harnessed to generate clean electricity. One of the main advantages is that the geothermal power sources do not depend on weather conditions with very high capacity factors. There are different geothermal technologies for different applications with distinct levels of maturity. Geothermal technologies for direct uses are the mature ones applied widely like for district heating, greenhouses and other applications. Another mature technology is the one for electricity generation from hydrothermal reservoirs with naturally high permeability, operating from 1913. Furthermore, many of the geothermal power plants are flash or dry steam plants. The medium temperature fields are used more for electricity generation and new technologies, still at demonstration stages, like the Enhanced Geothermal Systems (EGS) (IRENA, 2019).

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In order to enhance and promote dialogue and knowledge about geothermal energy and heat generation, the coalition Global Geothermal Alliance (GGA) was created in 1988, claiming and promoting this source of energy among governments and other stakeholders (IRENA, 2019).

- Hydropower – Hydropower or hydroelectricity, one of the first sources in the generation of electricity, defines the energy derived from flowing water into electricity. It is a renewable energy source because it is a type of energy depending on the cycle of the water that constantly renewed by the sun. For the production of hydropower, the amount of precipitations determines the amount of water available for producing hydropower (Eia, 2019).

The hydropower generated by the flowing water is using this power to drive turbines. The hydropower plans are with dams and reservoirs, or without. The first, the dams store water in order to meet peal demands or for concrete electricity generation purposes; and the second one, without dams, it is more environmentally friendly option in which it operated without interfering the flows of a river. For instance, Norway's 99% electricity comes from hydropower (IRENA, 2019).

- Ocean – Ocean energy is the world's largest untapped source of energy. The ocean can produce thermal energy from the differences in temperature and salinity; and the mechanical energy that exploits the power from tides and waves. On the one hand, energy is created by the sun's heat that warms the surface water more than the deep ocean water; the differentiation of water's temperature creates the thermal energy. On the other hand, the ocean's mechanical energy, tides and waves movements, the tides are driven by the gravitation pull of the moon and the waves, driven by the winds. The ocean thermal energy is constant, while tides and waves are considered intermittent sources of energy. The tidal energy is converted into electricity by using a barrage (dam), by forcing the water through turbines that activate a generator (Renewable Energy World, 2019).

In Europe, it is planned to deploy 100GW of production capacity of ocean energy by 2050, which means that this energy will be able to cover 10% of our electricity demand. European's companies are leaders in ocean energy with 66% of tidal energy patents and 44% of wave energy patents (Ocean Energy Europe, 2019).

- Solar – Solar power is the energy generated and harnessed directly from the sun. A renewable energy source with an inexhaustible supply and non-polluting, being the cleanest one. The solar energy is captured in different ways, solar heating and cooling, concentrating solar power and the photovoltaic solar panels that convert the rays into usable electricity. Photovoltaic (PV) panels convert sunlight directly into electricity, being one of the fastest growing technologies nowadays.

Solar panels installation is divided in three main groups: utility, commercial and residential. Residential-scale solar panel is installed usually on rooftops; commercial solar energy plants are installed at a greater scale with the aim to provide electricity to businesses and non-profits; and utility-scale solar energy plants are large and provide solar energy to a larger group of utility customers (Ashok, 2020). Furthermore, the second main generation way of solar energy is the concentrated solar power (CSP), which uses mirrors installed in fields of mirrors in order to concentrate solar rays and redirect them to a tall thin tower (SEIA, 2019).

- Wind – The wind is a free, clean and available renewable energy source. The wind turbines permit to harness the power of the wind and turn it into energy. There are two types of installations, the offshore and onshore. The offshore wind turbines are usually located on the continental shelf and being larger than the land-based turbines, they can generate more power. The wind produces electricity throughout the kinetic energy created by air in motion, which rotates the turbines and turns into energy (IRENA, 2019).

1.3 IRENA – International Renewable Energy Agency

The International Renewable Energy Agency (IRENA) is an intergovernmental organization that promotes the renewable energy transition and encourages governments to adopt policies that enable renewable energy investment, accelerate renewable energy deployment, technology and knowledge sharing and provides practical tools and policies advice, among others. In addition, IRENA serves as a platform for international cooperation and repository of technology, resource, policy and financial knowledge about renewable energy. There are 161 member countries actively engaged. IRENA has a leading role in the energy transformation (IRENA, 2019).

IRENA provides products and services as follows:
- Annual reviews of renewable energy employment;
- Renewable energy capacity statistics;
- Renewable energy cost studies;
- Renewables Readiness Assessments;
- The Global Atlas
- Renewable energy benefits studies;
- REmap, a roadmap to double renewable energy use worldwide by 2030;
- Renewable energy technology briefs;
- Facilitation of regional renewable energy planning;
- Renewable energy project development tools: the Project Navigator, the Sustainable Energy Marketplace and the IRENA/ADFD Project Facility. (European Commission, 2019)

Irena is a really useful source of information when it comes to renewable energies. It can be helpful when deciding the best energy source for a concrete situation, as it not only has information on the different types, but it also serves as platform for intergovernamental exchange in renewable energy, which means there is also political information that can be useful when making a choice.

1.4 Best Practices of renewable projects

Case 1: *Solmove – Smart Solar Streets*

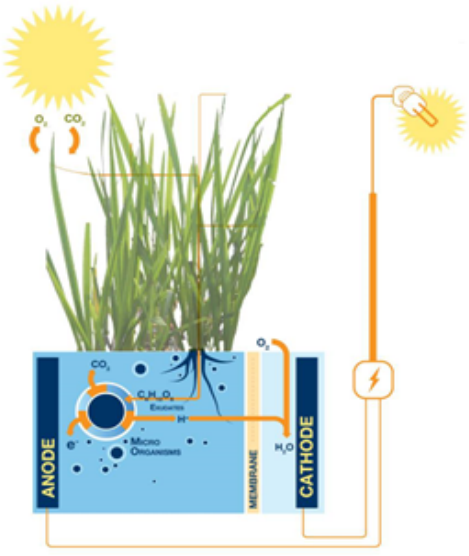
(Solmove, 2019)

Solmove is a German technology start-up based on proven photovoltaics in combination with a stable and innovative glass surface. It works on the bases of a special structure that optimally directs sunlight on the underlying solar cells. It I a solution that equips road networks with solar mats, which also absorb sound and can be equipped with a de-icing function. It is planned to be able to directly power electric vehicles. The technology produce clean and renewable energy.

The product offers some of the following benefits :

- **Clean electricity.** The mats generate electricity from a renewable source and can supply electric cars with power. The solar streets are safe and smart as well as large power plants.
- **Cost-efficiency.** A solar street has the characteristic of earning money by producing electricity.
- **Nature – friendly.** The conventional solar plants and wind turbines occupy large areas, but the solar roads of Solmove are installed and laid on existing surfaces.

Case 2: *Electricity generated from Living Plants*



Source: (Holland Trade and Invest, 2019)

The Istituto Italiano di Tecnologia (Italian Technology Institute) in Pisa is harvesting electricity from plants, an innovative application that allows them to discover that some plants have the capacity to transform mechanical forces into electrical power. When the leaves move or touch another material, it occurs a process named electrification, producing the flow of the power from the branches to the stem. The study show that a single leaf can produce 150 volts, enough to simultaneously power 100 LED lights at every movement. The plant keeps growing while electricity is produced; it is possible to produce food and nature while producing energy (Acciona, 2019).

This innovation has been used at small scale such as lighting LED- lights and powering WiFi hotspots. The system generates sustainable electricity and other environmental advantages.

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Chapter 2 - Strategic Alternatives for Green Future

2.1 Green Growth

Nowadays, our society is facing two main challenges:

- The need of expansion of the economic opportunities for everyone;
- The environmental pressure and need for change toward sustainable ways of life.

Green growth is the one that connects both in order to meet the challenges and allows the exploitation of possible opportunities to face both challenges. Green growth is the combination of economic growth and development while considering environmental issues, ensuring that natural assets continue to provide the resources. It provides a different approach for sustainable development, in order to achieve concrete and measurable progress across environmental and economic pillars. By focusing and developing green growth strategies added to the canalisation of innovation and innovation, it is possible to promote an economic development on sustainable basis.

The Green Growth initiative appeared in 2010, developed by the OECD and officially launched in 2011. The OECD described this initiative as a promotion of economic growth while making sure natural resources remain at a high level, with the required quality and quantity. The Green Growth initiative was highly connected to green economy, as it was also devoted to stimulating investment, competition and innovation that support sustainable growth and result in new economic opportunities.

Green Growth is fed on a series of sources and channels that can facilitate the effective impact it can have when addressing environmental challenges:
- Incentivate the **productivity** through a more efficient use of resources, while reducing waste and energy consumption.
- Encourage **innovation,** allowing the appearance of new job opportunities.
- **New markets** creation through the increased demand for green technologies.
- Boosting the **confidence** of investors by ensuring a higher stability regarding the environmental issues.
- Promote **stability** with balanced macroeconomic conditions that recude the volatility of resource prices and support fiscal consolidation.

When Green Growth Strategy was presented by the OECD, it also included a series of next steps planned to promote a national growth of the government policies regarding green strategies. It is expected by the OECD to collaborate with other international organisations (such as the UN, the World Bank or the Global Green Growth Institute), as well as with relevant stakeholders, in facilitating an exchange of experience and best practices that promotes a growth in all countries based on green strategies. (OECD, 2011)

2.2 Alternatives for Green Growth

Examples of Types of Policies

Cap and Trade

Cap and Trade is a general term for government regulatory program with a market approach, created and designed with the aim to limit (''Cap'') or control the level of emissions that pollute by providing economic incentives.

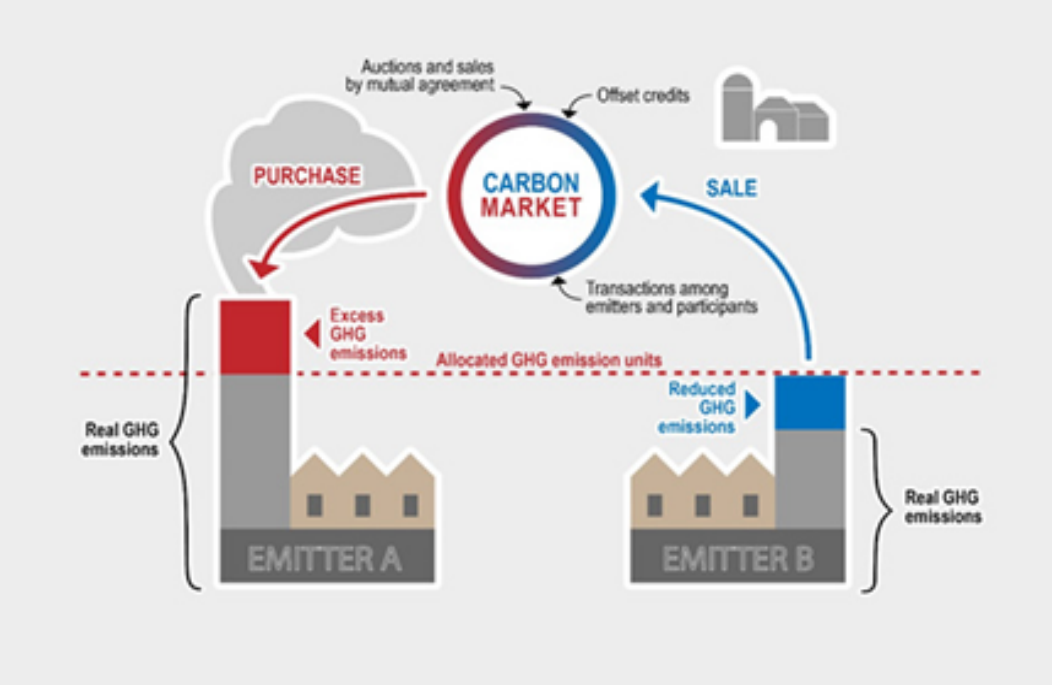
Governments set the cap across industries, sectors or the whole economy, adding penalties for violations or non-compliance. The main greenhouse emitters that are crapped are carbon dioxide and related polluters that contribute for global warming. The cap is splitted into allowances, each allowance permitting a company to emit a ton of emission. The allowances are distributed by the governments on free bases or through auctions. Furthermore, caps decline overtime, pushing companies to reduce their emissions in a more effective manner.

The trade refers to the market part of the policy, the buying and selling process performed by companies in order to acquire allowances that would let the company emit a certain amount. Being a process in which supply and demand set the price, it incentives the companies to save money by reducing or cutting down emissions in the most-effective way. The trade gives flexibility to the companies, being able to sell allowances by reducing their own pollution level faster, and sell it to companies that pollute more. It supposes an incentive for companies to invest in R&D and innovation, to change their processes and cut pollution (EDF, 2019).

The Cap and Trade system is a market system, value for emissions are exchanged and it incentives companies to invest in cleaner technologies, not to buy permits and have higher costs. However, on the other hand, it is considered that if governments decide to set a high level of cap, it might have a negative effect and lead to higher emission of polluters (Energia y Sociedad, 2019)

The Cap and Trade, being a type of policy, can be found implemented in different ountries and at different levels. For example, it was introduced in the European Union in 2005 with the EU emissions trading system (EU ETS), which also operates in Iceland, Liechtenstein and Norway. The most relevant information regarding EU ETS is:
- It limits emissions from more than 11,000 heavy energy-using installations (power stations & industrial plants) and airlines operating between these countries.
- It covers around 45% of the EU's greenhouse gas emissions.

More information about the way Cap and Trade policies are held in the EU can be found in this link. (European Commission)



Source: Cap and Trade (Gouvernement du Québec, 2019)

Carbon Tax

Carbon tax is a policy that establish a tax/fee on the carbon emissions of fossil fuels for decarbonize, eliminate the use of fossil fuels and protect the environment. Users of carbon fuel must pay a fee because it release carbon dioxide. It is an incentive, a monetary approach, to switch to clean energy by making it more rewarding (C2ES, 2019).

Source: (Dolsak & Prakash, 2017)

The Carbon Tax is applied on the fuel's carbon content, because the amount of CO2 release is proportional to the carbon present in the fuel. It is possible to establish the Carbon Tax directly to the fuel when it is being extracted or imported/exported. The Carbon Tax is payed using the existing tax collection mechanisms: ''upstream'' and fuel suppliers and processors can pass on the cost of the tax to the extent that market conditions allows, and in this way it motivates consumers and producers to reduce their carbon dioxide emissions, by being a monetary incentive. However, the carbon present on manufacturing products, such as the plastics, if it is not burned, will not be charged with a fee or any tax. In the same way, the CO2 released during production but sequestered and not released, will not be taxed.

How it works: Governments tax the companies for pollution (CO2 emissions) and this cost of the taxes is added to the sale price of a product or service, so the tax is passed on to the customer. Therefore, those companies with lower emissions will be able tooffer their products or services at lower prices, and the customer have at its disposal a cheaper and low-polluting product or service. It becomes a financial incentive for the competitive companies to reduce emissions, and a portion of the tax is invested in research/ green development or for socially needed households (Carbon Tax Center, 2019).

As in the case of the Cap and Trade, the EU controls the carbon tax through the EU ETS. More information can be found in this link. (European Commission)

Examples of Social Movements

De-growth

De-growth is the literal translation from the French word meaning reduction, 'décroissance'. It is a social movement that coverage critical ideas and political actions, as the transition and downscaling of production and consumption to increase social and human well-being and enhance ecological sustainability. 'De-growth' is a movement that aims to re-politicise on the socio-ecological transformation, criticizing the current development (Degrowth, 2019).

De-growth, an economic and social movement and critique of the paradigm of economic growth, is based on the need of reducing global consumption and production, advocating for a social-ecological sustainable society, and replacing GDP with the Wellbeing indicator as indicator of prosperity. Therefore, De-growth promotes a society within resources and localized economies distributed in a more equal way by democratic institutions, based on ecological responsible decisions and actions. It proposes a transition and transformation to a society with lower but sustainable level of production and consumption, transforming efficiency into sufficiency and innovation not focuses merely on technology, but on new social and technical manner to be developed in order to live in a cooperative and frugal manner.

However, there emerge a conflict because the primary policy of many governments is the economic growth and it leads to a conflict between the economic growth and environmental protection (Degrowth, 2019).

Green New Deal

The Green New Deal is a Keynesian green model. It consists in investing to transform the economy into a more sustainable economy based on renewable energies with a sustainable growth. The idea is to generate a green growth strategy and impulse international economy throughout an investment in sustainability that will also generate new green jobs. The main objective of the Green New Deal is achieve a socio-economic change with zero emission by 2050, creation of quality high-wage jobs, clean and sustainable environment, changes in the industries and infrastructure, and improve justice and promote equity. The investment should be done on those policies and measures that promote balanced economic growth in a long term. In addition, it is needed to invest even more on policies such as development of the circular economy, renewable energy and energy efficiency (European Commission, 2019).

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Source: (Pressenza London, 2019)

The Green New Deal is a plan promoted in the United States with an enormous ambitious perspective that aims to promote a radical change of the American economy, as a measure to fight against the climate change and offer the quality jobs. The word 'Green' refers to the climate and 'New Deal' refers to the New Deal the president Roosevelt established in order to face the consequences from the Great Depression in the Thirties (European Commission, 2019).

The European Commission presented the EU Green Deal in 2019 with fifty concrete actions and measures in order to convert the European continent in the first one to be environmentally neutral. The EU Green Deal aims to achieve by 2050 a clean economy in order to protect the natural habitat with zero emissions. The measures are the mirror of the EU and its citizen feeling about the problems that the climate change suppose. It considers that actions to reduce or eliminate the negative effects of the climate change will be essential for innovation improvement. The European Commission plans to create a transition fund for the regions depending on fossil fuels in order to transform the EU economy into the one leading the change to a sustainable economy and society (Mundial, 2019). Therefore, the European Commission aims to reduce the emissions by 50% or 55% by 2030.

Examples of Technologies

Silver Bullet

The silver bullet describes the innovative idea of using technology to remove he carbon dioxide from the atmosphere. However, even being a warming temperature gas, the atmospheric concertation is very low, making it very difficult to be captured. The captured CO2 can be converted into liquid fuel by mixing it with hydrogen, then passed over a catalyst at 900C in order to form carbon monoxide. Adding more hydrogen, it turns into a synthesis gas and this gas is turned into a synthetic crude oil.
However, environmentalists are concerned because this technology could provide a false hope, and foster the continued dependance on fossil fuels that affect the environment. It is important to reduce the consumption and reduce the carbon footprint (McGrath, 2019).

2.3 The OECD Green Growth Strategy

The OECD has developed the Green Growth Strategy in order to provide a framework with green growth tools, and indicators for a sustainable economic growth through a sustainable energy, natural resources and valuation of ecosystem services. It is a policy to encourage the shift to a greener path.

The OECD, by stimulating an eco-innovation and addressing the transition to a greener economy (investment, taxation, jobs, trade and development) aims for a low-carbon economy compatible with growth (OECD, 2011).

The following points are recommendations part of the Green Growth Strategy, for governments for identifying policies in order to achieve the most efficient way for the shift to a greener growth:
- Green jobs and social aspects.
- Green taxes and regulatory approaches.
- Industrial restructuring and renewal.
- Fiscal consolidation.
- Green technologies.
- Peer reviews.
- Co-operation between OECD countries and emerging economies.
- Involvement of stakeholders.

Green Growth policies can be considered structural reforms tailored to the specific country circumstances (OECD, 2019). Among their aims we find:
- **Enhance productivity** by incentivating the creation of opportunities for innovation and value creation, spur the use of natural resources in an efficient manner and allocate resources.
- **Contribution to fiscal consolidation** by the establishment of green taxes and elimination of environmentally harmful subsidies.
- **Open up new markets** throughout the consumption and demand stimulation for green goods, technologies and services.
- **Reduce risks of negative shocks to growth.**

2.4 Best practices for a greener future

Case 1: Cochin International Airport

The Indian Cochin International Airport is the world's first solar-powered airport with more than 46.000 solar panels converting the sunlight into energy. The airport started with a project starting with the instalment of 400 solar panels in 2013. The main reason for the instalment of solar panels was the success of the project in 2013 and the cheapness of the energy provided through renewable sources. The solar plant is producing more energy than the needed, the rest is banked with the state power grid for special required / needed moments (Cochin, 2015).

Case 2: Canal Solar Power Project

The Canal Solar Power Project is a project in the city of Gujarat, India, based on the establishment of solar panels in the network of canals of Narmada. The project was awarded to SunEdison. The pilot project developed by Gujarat State Electricity Corporation (GSECL) in collaboration and support from Sardar Sarovar Narmada Nigam Ltd. (SSNNL), the organization that maintains and owns the canal network.

The usage of the banks for covering the canal by installing solar power panels meant an exploitation of the existing infrastructure, which saved an additional investment to the government. The used part of the canal is the 10% which is estimated to generate 2.200 MW of solar power (The Economic Times, 2013).

Source: Canal Solar Power Project (erewise, 2013)

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Chapter 3 – The 4th Indutrial Revolution

3.1 The 4th Indutrial Revolution – Concept

Source: (Bachousi, 2018)

The Fourth Industrial Revolution is the representation of a fundamental change in human development empowered by technological innovation and advances.

Following the First Industrial Revolution of steam powered factories, the Second Industrial Revolution meant the application of science to mass production and manufacturing, and the Third Industrial Revolution, the jump into a digitalized word that made the way to the Fourth Industrial Revolution, which merges and is the result of the digital, physical and biological innovation. The Fourth Industrial Revolution supposed new technologies such as the 3D Printing, genome editing, Artificial Intelligence, robotics and augmented reality. The new disruptive technologies are changing the lifestyle and working patterns (Iberdrola, 2019).

The Third Industrial Revolution was characterized by a digital revolution based on computer development and IT. The Fourth Industrial Revolution is characterized by the explosiveness of its development and disruptiveness, differentiated by the tremendous impact of new systems, the speed of technological breakthroughs and the pervasiveness of scope.

The Fourth Industrial Revolution has created a world where physical and virtual systems interconnect and cooperate in a flexible way at a global level. It is the fusion of technologies going from renewable energies to quantum computing, building this interaction across different domains.

On the one hand, the positive effects of the Fourth Industrial Revolution are the increased productivity, risk reduction at workplace, efficiency and quality in processes, decision-making process, data-based tools and increase in competitiveness by development of customized products. On the other hand, the drawbacks are the dizzying speed of change and the need to adapt, the high dependence on technologies and the digital gap, among others (Salesforce, 2019).

3.2 Technologies of the 4th Industrial Revolution

The technologies that characterize the 4th Industrial Revolution are the following:

• **Artificial Intelligence (AI).** Computers capacity to recognize complex patterns, processing information and making recommendations.

• **Blockchain** in a secure, transparent and decentralized way of sharing and recording data. For instance, the best known blockchain application is the Bitcoin currency. It is a technology used for other applications like supply chain traceability and secure sensitive medical data.

• **Virtual Reality (VR)** is a digital experience that simulates the real world and the augmented reality, merging the digital and physical spaces.

• **Biotechnology** exploits the biomolecular and cellular processes in order to develop new technologies and products to produce new pharmaceuticals, industrial manufacturing processes and cleaner energy sources.

• **Robotics,** which includes the design, manufacturing and production of robots for both personal and commercial purposes. Robotics are used in fields such as manufacturing, health, safety and human assistance. In addition, the development of cobots, robots designed to interact physically with humans in collaborative environment, are considered as future key advance for the industry.

• **3D and 4D Printing** enables the possibility to print parts for personal and manufacturing purposes. It makes it possible to produce at lower costs, with less materials and tools needed, and faster than the traditional processes. Moreover, it makes possible the customization of the parts.

• **Computational technologies.** The technology allows the creation of smarter computers, with capacity to process a massive amount of data in a faster way. It allows the safe storage of data and access to any kind of information with Internet access. The implementation of computational technologies allows the creation of complex data models and the rise in speed. The creation of innovative materials and the capacity of energy capture, storage and transmission represent a rising market sector.

• The **Internet of Things (IoT)**, covers the aggrupation and interconnection of different devices through a web where the interaction is created. For instance, it allows the businesses to collect customer data from connected products and use the data in order to offer tailored services and products.

3.3 Industry 4.0 and its Impact

The new technological revolution brought economic, cultural and social changes with an impact on the governments, economy, society and individuals. The most relevant impact is probably a result of the ''empowerment'' of relevant stakeholders and actors, and its own recognition as part of a distributed power system that involves collaborative forms of interaction.

The other positive impacts might be:

- The technological development and innovations, the digital services, computing devices and networking have positive effects such as quick and accessible ways to education and information. Moreover, new educational disciplines are rising regarding those fields and offer new opportunities and skill development.
- The technological development has effects on social media, making social platforms and apps more accessible and consequently more active, where communication is easily build and users can share opinions and ideas.
- The increase on online shopping sites and quick delivery services make commodities more accessible and increase the economical benefits. In addition, thought the technology application, the customer or user receives smart recommendations.
- Different sectors are benefited by the Industry 4.0, like the medical sector and the improvements in medical services and neuroscience. The agricultural sector has been influenced too by Bioengineering, machines' improvement and incorporation of Artificial Intelligence for crops control and management.
- The communities and regions are more interconnected, turning the world into a global village within which people and products are easily accessible.

The negative impacts might be:

- The over-reliance on technology has effects on the will of people, who prefer to just trust on computer instead of using intellect and physical capacities and power by themselves.
- Social media effects include the distancing between the person and the physical society. People are starting to prefer connecting with people in the virtual world rather than the physical one. Moreover, news, comments and other kind of content are easily spread, which means it is easier to find false news or build conflict between people.
- The Fourth Industrial Revolution supposed technological advancement in tracking systems though digital devices, social media platforms and online shopping sites, among others. The negative effect is that individual privacy has been widely lost.
- The advancement in automotive and robotic technology affects and creates a real concern and dialogue for the future of employment. However, human skills are still considered invaluable compared to Artificial Intelligence.
- The massive industrialization, experimentation, development of technologies, increased urbanization, deforestation, rapid population growth and food and water insecurity, among others, have negative and damaging effects on the natural environmental balance (Nath, 2018).

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3.4 L'Oréal's Innovations and tech 4.0

L'Oréal is not only a cosmetics and self-care company, but also a big beauty tech company. The company works on understanding both customer trends and preferences, as well as the digital changes the society is facing and experimenting, and manages to arrive to the customer not only via social media channels but offering a different innovation.

The brand developed products applying different innovative technologies which represent examples of the aspects included previous sections of this module, as can be seen in the following actions:

Source: Perso (Catanese, 2014)

Example 1: The L'Oréal's Makeup App, called **Makeup Genious** (L'Oréal Paris, 2019) is an example of Virtual Reality, because it allows customers and users to digitally try and experiment different make up products before they purchase them. The Makeup App allows customers to try out make up or change up their hair color and it consists in the following:
- Selection of a product from the brand that the customer would like to try on.
- Click on Tap&Try and the customer will be able to see the new look through a live image from the camera, or in an uploaded selfie.
- Possibility to flick through the different options and shades to find the suitable one for the customer.


Source: (LÓréal Spain, 2020)

Example 2: L'Oréal is in the process of developing Perso (Catanese, 2014), a smart skincare device that uses Artificial Intelligence, user's preferences and location data in order to formulate a personalized moisturizer, foundation and lipstick. As it can be seen in the image, Perso will be a physical device working through motors that have been patented by the company. Perso is a product developed in L'Oréal's technology incubator where physicists , UX specialists, hardware designers, engineers and data scientists work together and merge knowledge and technology to build and create new, i nnovative products through Virtual Reality and Artificial Intelligence. The product is expected to be launched in 2021.

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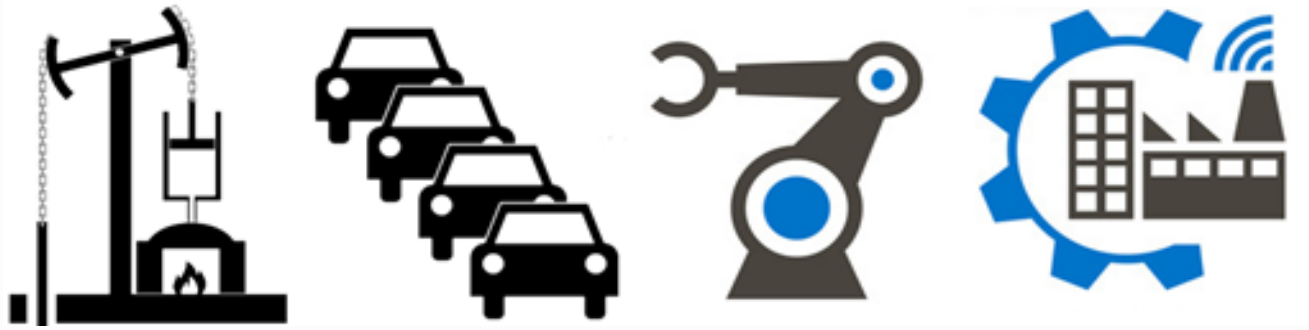
Chapter 4 - Society 5.0

4.1 Society 5.0 – Concept



Source: Flaticon Icons (Flaticon, 2020)

Society 5.0 is a societal transformation plan of Japan, described as a ''super-smart society''; a human centred society that balances economic advancement. The Society 5.0 follows the hunting society (Society 1.0), agricultural society (Society 2.0), industrial society (Society 3.0), and information society (Society 4.0), becoming the society of the digital transformation of manufacturing. This new futuristic approach goes beyond digitalization of the economy. It aims to establish digitalization across all levels of the society, promoting the digital transformation of the society; a society in which Artificial Intelligence, Internet of Things, Big Data (analytics), cyber-physical systems and VR/AR (Virtual Reality/Augmented Reality) are the main areas of consideration.

It is a social reform based on innovation that aims to achieve a forward-looking society in which every person has the opportunity to lead an active and enjoyable life. A society that breaks down the sense of stagnation, robotization at all levels, connection and data sharing through IoT and liberation of all kind of constrains. It is a societal transformation plan for the Japanese society, because Japan is facing a particular challenge with the aging of its population. By establishing smart and innovative approaches, Japan expects to be able to face the challenge.

Society 5.0 builds a convergence between physical space and cyberspace. With the Society 4.0, it is possible to access to a cloud service in the cyberspace though the Internet. However, in the Society 5.0, the information accumulated in cyberspace through sensors is analysed by Artificial Intelligence at a physical level, and the outcomes come back to humans physically by different manners, not just as cyberinformation (i-scoop, 2019).

4.2 Society 5.0: Economic Development and a Human-centred Society

The current society is changing around the world, and experimenting drastic changes. The economical development has positive effects on people lifestyles, making it more prosperous and convenient, with a longer life expectancy and an aging society. The development and globalization interconnect the different activities and processes, increasing competitivity and problems regarding wealth and resources inequality. Therefore, problems regarding social issues and environmental concerns are fomenting the need of solutions such as the support of sustainable inequality and redistribution of wealth, among others, in order to create and build economic and social growth.

New technologies, such as Artificial Intelligence and big data, can be used for encouraging progress and fight the challenges that the current society is facing. Japan is aiming to implement innovation and technologies in order to tackle the challenges and achieve economic growth and solutions to social problems.

The Society 5.0 aims to abolish differentiation and to diminish the challenges that the society faces. It works towards the elimination of regional, gender, language and age gaps. Furthermore, it permits the provision of products and services tailored to the preferences and needs to each individual.

Source: (Japanese Cabinet Office, 2019)

In addition, the convergence between physical space and cyberspace allows and enable robots and Artificial Intelligence information to be used to support or assist the needs or the work and tasks the human has done until now. The new society enables the optimization of the society and the organizational system, enables people to perform and have what they need at the time they needed it, eliminating those activities that are a cumbersome work of the human. Japan aims to achieve all these aspects, becoming a human centred society with high quality of life (UNESCO, 2019).

4.3 Society 5.0: The challenges

The Society 5.0 is an evolution, as the Industry 4.0, of societal stages (Cabinet Office, 2019):

With the Society 5.0., Japan decided to take digital transformation from individual organizational levels and parts of the society to a national transformation. However, the challenges faced are the following:

- **Legal System.** The existent laws need to be changed and adapted to the new implementation of the advanced techniques. In other words, regulatory reforms and digitalization of administrative procedures and processes are required.

- **Ministries and Agencies.** It will be required the implementation of an IoT system and the development and formulation of national strategies and integration processes.

- **Human Resources.** A society driven by technologies and digitalization will require reforms on education based on the promotion of IT literacy and the specialization on digital skills.

- **Technology.** It is required a Research and Development of technological advancement. The new society is based on innovation and technologies, and the role of technologies at all levels such as cybersecurity, robotics and nano technologies, among others, are essential.

- **Societal Acceptance**. The acceptance by the society is relevant because the change needs a social consensus, bringing to discussion ethical issues and social implications. This new kind of society requires the implication of the society as a whole, including the industry, citizens and governments, among others.

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4.4 Implementation of Society 5.0 – Toyota

Toyota, the automobile producer, planned a project for a ''city of the future'' for 2,000 people, which aims to create a city to test smart technology, autonomous vehicles and robot-assisted living. The project plans to be established in the Woven City, at the foothills of Japan's Mount Fuji. It is a new concept, different from just a ''smart city'', a living laboratory created to be studied and researched by engineers and scientists in order to test emerging technologies in a real-life environment. The name of the city, Woven City, references to the verb weabe (synonim of knit), and it is perfectly represented by the streets that appear as they were woven, forming an orderly, flexible and strong urban mesh. The project is fully sustainable, with rooftop solar panels and hydrogen fuel cells. Therefore, the transport vehicles are planned to be only zero-emissions, autonomous vehicles (Holland, 2020).

The main difference between this project and a regular smart city is that the project does not pretend to be a smart city, but an experiment that aims to raise the idea of how such a city could be and look like. Moreover, it measures the ability and capacity of reproducibility of the innovation created by researchers.

Toyota defines the city as „a living laboratory with full-time residents and researchers who will be able to test and develop technologies in a real environment", becoming a huge incubator of innovations in robotics, environmental innovation, artificial intelligence and sustainable mobility, among others (Toyota, 2020).

Source: 'City of the Future' (Mura, 2020)

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Chapter 5 – JOIN THE MOVE

1. Existing networks and supporting programmes.

The following links include different networks and supporting programmes which are related to the topics included in this module:

- Progress reports reported by EU countries on their progress towards the EU's 2020 renewable energy goals.
- National renewable energy action plans 2020
- Renewable energy directive at European level
- OECD work on green growth

2. Tools of reference to develop actions.

In these links, you can find tools that encourage the development of actions related to the topics included in this module:

- Analytical Tools for Renewable Energy Planning
- Renewables 2019 – Market analysis and forecast from 2019 to 2024
- Renewable Power Generation Costs in 2019
- Tracking SDG 7: The Energy Progress Report (2020)

3. Tips to taking action / recommendations / quotes.

When talking about accelerating the transition, business might have an important role in it, by contributing to a lower-carbon economy. Before defining and establishing a renewable energy is important to identify the company's motivations for procuring renewable energy, the adaptation of supporting goals and the commitment and identification of internal resources.

Suggested steps for establishing the strategy (Harrison, 2018):

Assessment of options: The first step is to analyze and take into consideration the available options considering different factors, in order to determine the feasible one.

It is important to consider the future policies that might affect the costs, availability and incentives for renewable energies. The Climate Policy Tracker for Business is a tool that helps businesses, assessing them about the effect of regulations on renewable energies.

After the consideration of relevant factors regarding the renewable energies and the business, it is important to consider the following questions:

- ''Is your real state portfolio suitable for onsite, renewable energy generation?'': leased assets require companies to liaise with the landlord of the property.
- ''If your real estate portfolio is suitable for onsite generation, what is the energy capacity of potential projects/installations?'': the energy capacity of potential projects/installations is important to calibrate the local procurement implementation.
- ''What is your time horizon?''

Creation of the strategy: it is important to define the strategy once the renewable energies are considered. A merge between the business and sustainability strategy need to be adopted. For instance, an organization with existing energy intensity and business growth, has to design a strategy that complements the existing objectives.

The motivations and objectives of the business, which make them turn to a sustainable approach and the implementation of renewable energy are important, and they need to be reflected in the strategy.

Identification of opportunities for collaboration: the collaboration with other organizations or the community, might be positive for achieving renewable and sustainable strategy objectives and minimize positive negative effects or barriers.

Renewable Enegies Online tools for SMEs and public sector to better adopt renewable energy sources

The following page offers information about XPRESS, an EU funded initiative that has created a search engine aiming at helping SMEs access to tenders and relevant information regarding renewable energies. XPRESS allows to gather data, share information, and match the needs of public procurers and SMEs in embracing renewable energy sources (RESs), an initiative funded by the European Union.

The direct access to the search engine tool is available in this link.

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Chapter 6 – TO GO FURTHER

This chapter provides you with different sources that will help you learn more about the aspects we have studied in this module. If you are interested in knowing more, do not hesitate to take a look at them.

Books

The Fourth Industrial Revolution Book: The Fourth Industrial Revolution by Klaus Schwab.

Relevant policies and organisations

- The European Green Deal – European Commission
- Green Technologies – Website of Green Technology
- EIT European Institute of Innovation & Technology
- Report 'Towards Green Growth' – OECD

Videos

- Bloomberg Green Tech
- TEDx Talks – Atom Scale Manufacturing: The Path to Ultimate Green Technologies | Robert Wolkow

Information from the European Commission

- European Commission – Research, technology and innovation
- European Commission – Eco-Innovation
- European Commission – Sustainable Energy Week

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Chapter 7 - PRACTICAL ACTIVITIES

In this chapter some relevant information refering to practical things that can be used by companies has been collected:

7.1. Gold Standard – Carbon Markets

Offsetting carbon emission is an effective way to reduce emissions globally and create sustainable development benefits for communities around the world by purchasing carbon credits deciding on the project. At the following link is possible to find the variety of projects from which you can inform youself and decide what kind of actions you can take:

~ Ethiopian Forest Regeneration $18.00 USD/Tone: regeneration and new establishment of forests on Mount Damota, which contributes to a sustainable income for rural communities.

~ Utsil Naj – Health Homes for all $28.00 USD/Tone: a project created to address climate change in the 'Dry Corridor' of Honduras by promoting community sustainable solutions.

7.2. Measure your climate impact

Understand the energy use of your activities and its carbon footprint. It is possible to get an estimation of it through the WWF UK CARBON FOOTPRINT CALCULATOR by performing and answering a questionnaire.

Take the challenge and discover your Carbon Footprint!

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Conclusion: This is a beginning - My action

We've given you some advice; now it is time to turn this info into action… your action!
Write here your own remarks:

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