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Climate finance and the analysis of climate policies impacting SMEs

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A society grows great when old men plant trees
whose shade they know they shall never sit in.
Greek Proverb

Abstract

Climate change is one of the most serious problems humanity has ever faced. Rising temperatures along with the sea, extinction of entire species of plants and animals, fundamental for the balance of the Earth's ecosystem and the always most frequent succession of unpredictable extreme natural events are just some of the manifestations of this transition.

For decades, the most influential international organizations have involved world powers in large-scale agreements to try to mitigate and limit these tragic consequences that by now influence our daily life. In doing so the United Nations has played a fundamental and pioneering role. UNFCCC, Kyoto Protocol and Paris Agreement are the most important international treaties and conventions defined to fight climate change.

European Union is at the forefront in facing this challenge. Indeed, trough the implementation of increasingly ambitious targets, plans and strategies it has conveyed a sustainable culture in all its member states, proving to be stubborn and diligent in being on track toward goals set.

This thesis work is structured in several sections. At European level, all the policies and instruments to deal with this phenomenon are analysed first, then moving to the level of the single members of the EU, the extent to which each individual state is compliant with the targets imposed is studied. The ultimate goal of this thesis work is to analyse the impact that these extreme natural events combined to the national and international mitigation policies and instruments have in European small and medium-sized enterprises operating in the transportation sector. The economic variables taken into consideration for this research are: operating revenues, total assets, current liabilities and non-current liabilities. The result of this research will bring evidence that temperatures considered extremely hot or extremely cold have, on average, a non-negligible impact on these economic variables.

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Terminology and acronyms

CO_2 eq	Carbon dioxide equivalent (is a measure that expresses the impact on global warming of a certain amount of greenhouse gases compared to the same amount of CO_2)
EEA	European Environmental Agency
EED	Energy Efficiency Directive
ETS	Emission Trading System
EU	European Union
EU 27 + UK	Data relating to the 27 Members of the European Union plus United Kingdom (outside the EU at the end of 2020)
GDP	Gross Domestic Product
GHG	Green House Gases
GICS	Global Industry Classification Standard
log(x)	Base-10 logarithm of x
MS	Member State
MTOE	Million Tonnes of Oil Equivalent
SME	Small Medium Enterprises
t	Tonne
UN	United Nations (is an intergovernmental organization that aims to maintain international peace and security and achieve international cooperation among nations)

Chapter 1

Introduction to the problem of climate change

Climate Change is the defining issue of our time and we are at a defining moment. The impacts of climate change are global in scope and unprecedented in scale. Without drastic action today, adapting to these impacts in the future will be more difficult and costly.

The first effects of global warming have already begun to impact: here is a list of the main effects we are experiencing on our skin, and the consequences if we do not reverse course as soon as possible.

- **Rising temperature**

  A recent study published in *Nature Climate change* [1] analyses the risks of hypothermia, highlighting how they have increased since the 1980s: even if we reduce CO_2 emissions immediately, by 2100 48% of the world's population would still be in danger; the percentage rises to 75% if we do not take action.

- **Rising seas**

  The rise in temperatures is felt even more at the poles, where the ice and ice sheets are melting, with consequences for the level of the oceans: they are rising at twice the speed of the 1990s. According to experts, at best we should expect one meter more by the end of the century.

- **Disappearance of plant and animal species**

  Starting with the melting ice, which endangers polar bears (it is estimated that two thirds of them will disappear by 2050) and penguins (from 32,000 breeding pairs 30 years ago to 11,000 today), 1 in 6 species are at risk of extinction. According to researchers, we are living and causing the sixth mass extinction, the first caused by a living species; what is worrying is not only the number of extinct species, but also the decrease in the number of subjects that constitute each species: the number of specimen on the planet has already halved.

- **Ocean acidification**

  Approximately a quarter of the CO_2 emitted into the atmosphere ends up in the oceans, contributing to changing their PH: since the beginning of the industrial era, acidity has increased by 26%, with serious consequences for the marine ecosystem. Coral reefs, for example: already at high risk of extinction (35% of corals have died or are dying), according to scientists we could lose them by 2050. Plankton, crustaceans and mollusks are also at risk, and then the entire food chain; the damage is closer than we think: if once the experts talked about centuries, now they have been corrected in tens of years.

- **Hurricanes and storms**

  Climate change is predicted to lead to increasingly extreme weather phenomena, both in terms of frequency and intensity; in the coming years we must expect cyclones and tropical storms with greater destructive potential.

- **Desertification**

  The whole Mediterranean area is at risk of desertification: this means a degradation of the soil from fertile land to desert, compromising productivity. According to WWF data[1], by 2030 this phenomenon will force 700 million people to migrate.

- **Decline in fresh-water resources**

  One of the most underestimated consequences is the reduced availability of fresh water, which is closely linked to reduced rainfall. Together with evaporation due to high temperatures and continuous water withdrawal from reservoirs, this has led to a decline in at least one third of the world's most important rivers between 1948 and 2004. If we do not stop exploiting resources and temperatures continue to rise, we will be in trouble: according to the UN we will already have exhausted 40% of the fresh water on the planet by 2030 [2].

- **Massive migrations**

  Climate refugees struggle for survival with others in the same conditions, often triggering conflict and war. As written in the important report *Migration and Climate Change* by the IOM (International Organization for Migration) on climate migration [3], it is an uncertain estimate, which requires massive extrapolations, i.e. forecasts out of the known values of the phenomenon. The World Bank has provided a quantitative estimate: 143 million people forced to leave their homes because of extreme weather conditions or environmental conditions that have become unlivable [4].

- **Spread of disease**

  Bacteria and viruses also learn how to adapt, especially if they find a favorable climate. The rise in temperatures has allowed the spread of diseases typical of tropical areas, such as malaria, cholera and dengue fever.

[1] for further information visit:
`https://www.wwf.it/news/notizie/?23680/Giornata-mondiale-contro-desertificazione`

- **Economic losses**

  The European Environmental Agency (EEA) has recently published research on natural hazards in Europe caused by climate change. Between 1980 and 2017, extreme weather phenomena caused economic losses in the 28 EU MS of 426 billion (in 2017 Euro values)[2], including floods, storms and droughts; among the countries, Italy suffered the most damage.

Even if the picture that comes out is far from encouraging, the most important thing must not be forgotten: if all the countries rowing in the same direction, the course can be reversed.

[2] https://www.eea.europa.eu/data-and-maps/indicators/direct-losses-from-weather-disasters-3/assessment-2

1.1 United Nations legal instruments

An important role in the fight against climate change is played by the United Nations. The UN is at the forefront of the effort to save our planet.

On 23 September 2019, Secretary-General António Guterres convened a Climate Summit[3] to bring world leaders of governments, the private sector and civil society together to support the multilateral process and to increase and accelerate climate action and ambition. Hoping that both the private and public sectors will actively contribute to the challenge of climate change, he said: "*We need more concrete plans, more ambition from more countries and more businesses. We need all financial institutions, public and private, to choose, once and for all, the green economy.*"

Over the years, there have been several summits involving the world's major countries with the aim of combating the increasingly important phenomenon of climate change. The main ones in chronological order are:

- **United Nations Framework Convention on Climate Change (UNFCCC)**[4]

  The ultimate objective of this Convention is the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropocentric interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

  The countries should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures, taking into account that policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost. To achieve this, such policies and measures should take into account different socio-economic contexts, be comprehensive, cover all relevant sources, sinks and reservoirs of greenhouse gases and adaptation, and comprise all economic sectors. Efforts to address climate change may be carried out cooperatively by interested countries.

  The Parties should also cooperate to promote a supportive and open international economic system that would lead to sustainable economic growth and development in all Parties, particularly developing country Parties, thus enabling them better to address the problems of climate change.

  Concerning the commitments, the Parties must develop, periodically update,

[3] https://en.wikipedia.org/wiki/2019_UN_Climate_Action_Summit

[4] https://unfccc.int/sites/default/files/convention_text_with_annexes_english_for_posting.pdf

publish national inventories of emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol[5].

They also must formulate, implement, publish and regularly update national programs containing measures to mitigate climate change by addressing emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, and measures to facilitate adequate adaptation to climate change;

- **Kyoto Protocol**[6]

  The Kyoto Protocol legally binds developed country Parties to emission reduction targets. The Protocol's first commitment period started in 2008 and ended in 2012. The second commitment period began on 1 January 2013 and will end in 2020. There are now 192 Parties to the Protocol. Countries that ratified the Kyoto Protocol were assigned maximum carbon emission levels for specific periods and participated in carbon credit trading. If a country emitted more than its assigned limit, then it would be penalized by receiving a lower emissions limit in the following period.

  Developed, industrialized countries made a promise under the Kyoto Protocol to reduce their annual hydrocarbon emissions by an average of 5.2% by the year 2012. Targets, though, depended on the individual country. This meant each nation had a different target to meet by that year. Members of the EU pledged to cut emissions by 8% while the U.S. and Canada promised to reduce their emissions by 7% and 6% respectively by 2012.

- **Paris Agreement**[7]

  It was adopted in 2015 to address climate change and its negative impacts. The deal aims to:

  - **Limit global temperature rise by reducing greenhouse gas emissions**. In an effort to reduce the global temperature increase in this century to 2 degrees Celsius above pre-industrial levels, while pursuing means to limit the increase to 1.5 degrees. It also asks countries to work to achieve a leveling-off of global greenhouse gas emissions as soon as possible and to become carbon neutral no later than the second half of this century.
  - **Provide a framework for transparency, accountability, and the achievement of more ambitious targets**. The Paris Agreement includes a series of mandatory measures for the monitoring, verification, and public reporting of progress toward a country's emissions-reduction targets; countries must report their greenhouse gas inventories and progress

[5] https://en.wikipedia.org/wiki/Montreal_Protocol
[6] https://unfccc.int/resource/docs/convkp/kpeng.pdf
[7] https://unfccc.int/resource/docs/2015/cop21/eng/10a01.pdf

relative to their targets, allowing outside experts to evaluate their success. The agreement includes commitments from all major emitting countries to cut their climate-altering pollution and to strengthen those commitments over time. The pact provides a pathway for developed nations to assist developing nations in their climate mitigation and adaptation efforts, and it creates a framework for the transparent monitoring, reporting, and ratcheting up of countries' individual and collective climate goals.

– **Mobilize support for climate change mitigation and adaptation in developing nations**. Recognizing that many developing countries and small island nations that have contributed the least to climate change could suffer the most from its consequences, the Paris Agreement includes a plan for developed countries to continue to provide financial resources to help developing countries mitigate and increase resilience to climate change.

Chapter 2

Climate policies and instruments applied at European and national level

The European Union places a strong emphasis on the fight against climate change, aiming to become the first clime-neutral continent by 2050 [5]. President Ursula von der Leyen said: "*We are acting today to make the EU the world's first climate neutral continent by 2050. The Climate Law is the legal translation of our political commitment, and sets us irreversibly on the path to a more sustainable future. It is the heart of the European Green Deal. It offers predictability and transparency for European industry and investors. And it gives direction to our green growth strategy and guarantees that the transition will be gradual and fair.*"

To date, the Union is on track with the objectives set for this decade, marked by the 2020 Strategy, demonstrating strong diligence in its vision.

Looking to the future, ambitious targets are set, in order to become always more competitive at international level, and to push each MS toward innovative strategies, as shown in the new package of measure set for the next decade, the European Green Deal [6]. The Council is constantly renovating, changing current directives and regulations to be always up to date with the most urgent needs of the community.

Although, the legislative bodies impose targets that affect the whole territory, they are then declined at the national level to better cope with internal synergies giving to each MS more flexibility.

A bundle of instruments is used by each nation to achieve the goals set for each year. These ones can be divided into two main categories: market- based and not market based ones.

2.1 Market based and non market based instruments

2.1.1 Market based instruments

Market-based instruments act by directly influencing the structure of the economic incentives affecting price, markets and other related variables, to contribute to the achievement of a certain climate objective, imposed at the legislative level. Therefore, these instruments associate a "cost" related to the negative externalities produced by pollutants, promoting, instead, sustainable projects.

Taxes

Through the use of taxes, the Government may impose a cost directly on the pollutant or on its output. This instrument induces the reduction in the use of harmful agents to the climate, in any sector, from industry to agriculture. Although taxes are an effective tool, they allow only to have absolute control over the economic variables and not on the amount of pollutant itself. Moreover, reduction targets can also go in conflict with the gain, because lower emissions lead to lower revenues obtained from taxation. There are different types of taxes, the most used are:

- **Tax applied directly to the pollution source**

  Carbon tax is an example of taxation directly applied to the pollution source, in which the Government sets a price for each ton of GHG emitted, which must be paid by emitters. Several states have already adopted the carbon tax inside and outside the European Union. Poland, Finland and Sweden adopted carbon tax instrument before 1991, then France, Spain, Ireland and Portugal. Outside the borders of the European union, instead, Japan, Argentina, Chile, Colombia, Mexico and Canada, adopted this instrument between 2007 and 2018[1].

- **Tax on inputs or output of a production process**

  Fuel tax is an example of exercise tax applied to the sale of products related to fossil fuels; indeed, is a typology of taxation related to the input of a process (transportation or more specific production sectors). At the European level, taxation of the same nature is also applied to electricity and to other energy products. Inside the Union, the process is harmonized even if the rate of taxation is different for each Member State. France adopted the taxation from 2017 and forecast to increase both diesel and petrol tax rate in 2022, also Germany, Netherlands and Poland follow the same path. Fuel tax is also adopted outside the boundaries of the EU. For example, from July of 2018, Colombia adopted the National Gasoline Tax (Impuesto Nacional a la Gasolina) applied to diesel, gasoline and to the other fuels used in the transportation sector.

[1] for further information visit:
https://carbonpricingdashboard.worldbank.org/map_data

- **Financial support mechanisms for climate-friendly products and activities**

  Financial support mechanism has the objective of encouraging the implementation of sustainable processes and projects among different sectors and companies. The economic incentives consist in a total or partial exemption from taxation related to that field, or to the application of subsidies or negative taxes.

Emissions Trading System (ETS)

ETS is one of the most efficient and effective market-based instruments in the field of environmental policies. Its great advantage is to facilitate the reduction of GHG emissions meeting the needs of different types of companies. In fact, the ones which fail to revolutionize their processes, because too costly, can buy allowances and credits from those that have managed to reduce their emissions structure in a cost-efficient way.

There are two main categories of emissions trading schemes:

- **Cap and trade mechanism**

  Given the total emission level of pollutants of a nation or industry, the maximum limit is set as cap, for a determined sector in a given period of time. The process is different with respect to taxation, because the controlled variable is the amount of pollutants emitted and not its cost. For this reason, is considered more efficient in helping MS to reach their targets. Allowances of emissions and permits could either be auctioned by a specific department of Government, which generate a revenue for the states, or allocated for free. The former case applies for that companies or sectors which suffer the most in changing their emissions structure. The reasons for that are different: their production process is strictly related to the use of fossil fuels, aviation sector is an example, or is too costly to change the cost and emissions structure and so the production could be moved in countries which this climate pressure is lower. This latter phenomenon is known as **carbon leakage** and is more frequent in energy-intensive industries. Today, cap and trade is used or is being developing in all parts of the world.

- **Baseline and credit systems**

  It is imposed a minimum performance commitment relative to some (pre-set) baseline profile of emissions. A regulator sets the baseline for each participant in this system and monitors actual emissions accordingly. Participants then “claim credits” based on their emission reductions after they achieve the relative baseline.

Removal of perverse incentives

Some measures, policies or practices induce behaviour that is harmful for biodiversity or for the environment itself. This tool allows the identification of these policies and practices and the consideration of their removal, phase out, or reform, for instance by mitigating their negative impacts through appropriate means. The sectors in which this instrument is most used are fossil fuel and food companies which are considered the most dangerous for biodiversity. Example of policies which can be removed or mitigated are tax exemption for pollutant activities, subsidies for harmful production or for companies that have been discovered not to use the appropriate methodology in terms of environmental respect and protection. These harmful policies are also known as "policy failures", because, has been discovered to generate negative externalities after their application.

Liability rules

Another instrument at the basis of climate law is related to liability rules, which are used to induce emitters in reviewing their behaviour in terms of environmental impact. Liability means *"the state of being legally responsible for something" (Oxford dictionary)*. The objective of this policy is to attribute to the operators of energy plant and to the owner of any company or activity, that produces directly or indirectly harmful agents for the planet, the legal liability for the consequences of such actions. In that sense it refers to as third party liability because the individuals potentially impacted by the consequences of different types of environmental pollution, have not a contractual relationship with the emitter itself. There may be differences in the degree of severity of liability. For example, strict liability requires the responsible entity to pay for damage even if the corresponding company took all required precautions without any proof of carelessness or fault.

Deposit refund

Deposit-refund is a system actually implemented in different states of European Union as incentive to recycle some types of waste such as plastic and glass. The mechanism of the policy is the following, when consumers buy some primary goods, such as beverages or other containers, they pay a surcharge which will be reimbursed when the empty packaging will be recycled in designated collection points. This instrument can be operated directly by a governments department or by a private and independent body. However, this policy needs an infrastructure behind, in order to organize and place the collection points and to monitor the supply of reimbursed money.

2.1.2 Non market based instruments

Non-market-based instruments are complementary tools of market-based ones having the same objective to propose, and in some case also impose, the implementation of mitigation actions to protect the environment and incentive a sustainable growth. The main difference between the two categories is that the non-market-based instruments have not transferable unit at the international level as, instead, market-based tools have. The United Nations Framework Convention on Climate Change (UNFCCC) gave the following definition of non-market-based instruments, in 2013: *"any action, activity or approach that addresses climate change, does not rely on a market mechanism and does not result in tradable units that can be used against binding emission reduction targets under the Convention"*. The main sub-categories are depicted below, considering the most used in the European Union.

Command and control regulations

Command and control regulations refer to binding standards set at the national and at the community level by governments authorities' trough legislative instruments. These standards mainly concern energy efficiency and GHG emissions. The effective application of the standards set is monitored and enforced legally in case of non-compliance. For this reason, this instrument is considered to be strongly effective in achieving the environmental targets. Command and control regulations mainly include three frameworks of application, ranging from process standards to product prohibitions:

1. **Framework standards**, which can include requirements for operating certification.

2. **Performance standards**, that set specific environmental targets for concerned parties without mandating particular technologies. The Regulation (EC) No 443/2009 [7] is an example of the imposition of performance standards in the transportation sector. In detail, the regulation set the reduction of carbon dioxide emissions for new passengers' cars.

3. **Technology standards**, which impose the use of specific technologies and/or prohibit the use of the ones that have been experimentally defined as harmful to the environmental. For example, the Directive (EU) 2009/125 known as Ecodesign Directive [8], introduced standards for the whole community in achieving energy efficiency. Including the advice, and in some cases the obligation, to replace traditional bulbs with led bulbs not only for public bodies but also for companies and private houses.

Even if the imposition of this instrument helps the European Union to meet its commitments in the fight against climate change, it requires significant investments by companies to adapt their production and business strategies to these binding changes.

Reporting requirements

Reporting requirements is a non-market-based instrument at the basis of the European strategy in fighting climate change. This tool allows to develop future legislation in line with the current needs of the Union but is also crucial in monitoring the commitment of the Member States toward the existing legislation. In fact, while it is fundamental to set targets for each MS, it is also necessary to monitor their progress with official reports available to all for consultation. In this way is possible to ensures transparency and fairness and also increase awareness of citizens. The EU, being part of the Kyoto Protocol and of the UNFCCC, has the obligation to report to the United Nations regularly the targets-imposed trough climate polices and instruments and the national progress towards them and annually the emissions of GHG per each Member State. Regarding the latter, the EU Climate Monitoring Mechanism Regulation sets the internal reporting rules on the basis of the international agreement highlighted before. Annual reporting covers the reporting of the emissions of seven GHG at the national level from all sectors: energy, industrial processes, land use, waste, agriculture, etc. This Regulation is active till January 1 2021, after that will be repealed.

Active (green) technology support policies

Active technology support policies, related to the green field, enable public bodies and department of Governments to provide incentives and promoting research, development and adoption of sustainable, innovative and disruptive technologies. NER 300 programme is an example of funding project established to help the R&D of new technologies in the Carbon Capture and Storage (CCS) and in the renewable energy sector. This program covered all the EU's Member States and concerned the allocation of funding to winning projects, generated from the sales of 300 million emission allowances, during the third trading period, from the New Entrant Reserve (NER). Another well-known policy, which belongs to this category, is the feed-in tariff, an instrument that provides incentives to the renewable energy sectors helping producers and in their investments in these technologies. This policy is necessary in the early stages of development of the technologies because of the huge non-refundable investments required to producing reliable and high-quality products. Moreover, it ensures long-term agreements and guaranteed prices to partially free producers from certain risks related to the uncertainty of the sector.

Information and voluntary approaches

Information and voluntary approaches use instruments that then improve consumer awareness about environmental impacts of products and practices and give information about the availability of less damaging alternatives.

2.2 Binding and Non-Binding objectives

In the area of climate change, market and non-market bases instruments are flanked by policies, on a legal basis, defined by the central Government of the European Union and subsequently declined and adapted by Member States. These policies are divided into two main categories, depending on the legal power that characterizes the specific government entity that emanates them: binding and non-binding objectives.

The European Parliament and the Council of the European Union have legislative power and are the bodies that define and issue binding policies. Instead, the policies defined non-binding target are delineated by the European Commission, with executive power.

2.2.1 Binding targets

Binding targets are goal established by EU legislation (regulations, directives and decisions) and European Council Presidency conclusions. The main areas on which these legislative decisions are focused are:

- Transportation
- Industry
- Financial Services
- Environmental
- Energy
- Design
- Buildings

Through the construction of a database (see Attachment *EU Climate Change policies* in 2.4), all the main policies currently active in the EU regarding climate change have been analysed. Here are reported the most recent ones at the time level, divided by sector.

Transportation

Regulation setting CO2 emission performance standards for new passenger cars and for new light, was first released on April 2009 and emended on January 2020 [9].

This binding European Law has the main objective to give its contribution in helping the community to reach its targets imposed by the Paris Agreement. It establishes restrictions in the emissions of carbon dioxide generated by the transportation sector, in detail, it targeted the new passenger cars and the light commercial vehicles registered in the EU. The objectives imposed for the average emissions generated by two type of vehicle are respectively, from the very beginning of 2020, 95 g CO2/km and 147 g CO2/km., measured until 31 December 2020. These new performance standards refer to all EU fleet-wide.

This Regulation increases the ambitious of these last objectives for the next ten years:

- until 31 December 2024 the initial target will be reduced by additional 10 g CO2/km;
- from 1 January 2025 the targets imposed in 2021 will be further reduced by 15%;
- from 1 January 2030 the targets imposed by 2021 will be further reduced by 37.5%.

Industry

Regulation on the establishment of a framework to facilitate sustainable investment, was first released on June 2020, and addresses the industry sector [10].

Its major aim is to define standard criteria in recognize economic activities and investments as environmentally sustainable. This regulation takes into consideration the following environmental targets, as key factors:

- climate change mitigation;
- climate change adaptation;
- sustainable use and protection of water and marine resources;
- transition to a circular economy;
- pollution prevention and control;
- protection and restoration of biodiversity and ecosystems.

Financial services

Regulation on sustainability-related disclosures in the financial services sector, was first released on November 2019 and then finally emended on June 2020 targeting financial services [11].

The main objective of this Regulation is to harmonize and promote transparency and fairness in the disclosure of environmental-related risks associated to financial products and processes. It set the rules for both financial market participants and advisers and imposes the publication of policies which integrated sustainability threat in their decision-making processes. In detail, the following information must be included and update in financial market participants websites:

- a description of the environmental or social characteristics or the sustainable investment objective;
- information on the methodologies used to assess, measure and monitor the environmental or social characteristics or the impact of the sustainable investments selected for the financial product, including its data sources.

Environment

Mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change, was first released on December 2018 and then updated on May 2013 and concerns environmental sector [12].

In detailed this Regulation focuses in defining the reporting process at the community and at the national level. It establishes a framework for:

- promoting fairness, transparency and data accuracy of reporting by the Union and its Member States to the UNFCCC Secretariat;
- reporting and verifying information relating to commitments of the Union and its Member States pursuant to the UNFCCC, to the Kyoto Protocol and to decisions adopted there under and evaluating progress towards meeting those commitments;
- monitoring and reporting all emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol on substances that deplete the ozone layer in the Member States.

Energy

Common rules for the internal market for electricity, was released on June 2019 targeting the energy sector [13].

In particular it establishes a framework to regulate the whole supply chain of electricity process in European Union. The main objective is promoting the competitiveness of the European system in relation to the infrastructures belonging to this category of energy. The values married by this directive are transparency and fairness in establishing prices and costs for final consumers together with high level of security and control, promoting a progressive and fast conversion to low-carbon system.

Design

Eco-design (establishing a framework for the setting of eco-design requirements for energy-related, was first released on December 2005 and subsequently updated on January 2020 targeting the establishment of new technological standards [8].

This Directive has as main objective to define, at the European Union level, standards to promote the environmental-friendly technological performances of products. A minimum level of energy efficiency is set for those targeted energy-related products and is mandatory, for producers, to be compliant with them. For the latter is, indeed, forbidden to compromise the agreed standards, otherwise would not be possible the place on the market of the products and the firms will face legal issues. One of the main criteria to establish the technological framework is the life cycle of energy related products and their costs which can be subjected to deterioration.

Buildings

Energy performance of buildings, first released on May 2010 and then updated on May 2018 targets the definition of standards in building's energy efficiency [14].

This Directive establishes guidelines to the energy efficiency compliance of buildings within the European Union. Several parameters are taken into account as cost-efficiency and the fact that some areas could be outdoor and subjected to climate and local conditions.

It lays down requirements:

- the common general framework for a methodology for calculating the integrated energy performance of buildings and building units;
- the application of minimum requirements to the energy performance of new buildings and new building units;
- the application of minimum requirements to the energy performance of existing buildings that are subject to major renovation;
- systems for the energy certification of new and existing buildings and the prominent display of this certification and other relevant information for public buildings (certificates must be less than five years old);
- regular inspection of boilers and central air conditioning systems in buildings and an assessment of heating installations in which the boilers are more than 15 years old must be conducted.

Each Member State shall establish a long-term renovation strategy to support the renovation of the national stock of residential and non-residential buildings, both public and private, into a highly energy efficient and decarbonised building stock by 2050, facilitating the cost-effective transformation of existing buildings into nearly zero-energy buildings.

2.2.2 Non binding targets

Non-binding targets are considered all the other objectives. This broad category includes goals set out in Commission communications and environmental action programs. They can also be shaped by European Council Presidency conclusions or EU legislation, including indicative targets, target values or targets subject to subsequent confirmation. Non-binding objectives are, therefore, quite heterogeneous and can vary greatly in their stringency and political strength.

A hydrogen strategy for a climate-neutral Europe

The European Commission's **strategy on the deployment and use of hydrogen** [15], has been released to the public in July 2020 and is one of the most ambitious and innovative plans of the community. Hydrogen is produced by the electrolysis of water, a chemical process in which oxygen molecules are separated from the rest. This product is called "clean", when the electricity used is generated by a renewable resource, therefore the process is completed without the emission of carbon dioxide. Hydrogen has different applications: it can be used as feed-stock, fuel, carrier and storage in a multitude of sectors, from industry and transportation to energy and buildings, helping in reducing the carbon footprint of the territory. In this regard, the EU Commission estimated that the implementation of this plan could reduce GHG emissions by a minimum of 50% and towards 55% by 2030, without the need for revolutionary investments for the private and public sector. In addition, further research has shown that, in relation to the urgent need for energy from the entire planet, clean hydrogen could solve 24% of this worldwide need by 2050.

At the concrete level, the use of this very important substance has been considered by 14 member states of the European Union in the future development of ad hoc carbon neutral infrastructure and the "Hydrogen Initiative" has been signed up by others 26 nations. However, in developing this plan different challenges have to be faced. The first and most important is the creation of large-scale infrastructure for the distribution and storage of hydrogen, but in doing so the countries of the European Union must think together and there is no room for the interests of the individual. At the tactical level this strategy is divided into three main phases. In the first phase the objective is to decarbonize the existing production of hydrogen, installing, all over the European territory 6 GW of renewable hydrogen electrolysers combined with the production of 1 million tonnes of clean hydrogen (produced by renewable sources). This phase will cover the four-year period from 2020 to 2024. In the second phase, ranging from 2025 to 2030, instead, the hydrogen has to consolidate in the EU's energy system. The renewable hydrogen electrolysers will increase to 40 GW while the production of renewable hydrogen will instead increase to 10M tonnes in the whole territory. Concerning the last phase, starting from 2030 onward the production of hydrogen has to be boosted at large-scale.

The conversion towards the production and use of sustainable hydrogen is crucial in the race to achieve a sustainable zero emission future. Moreover, it can bring about a turning point in the economic recovery after the Covid-19 epidemic, as the development of the necessary infrastructure can give a boost to the economy by creating new jobs.

Clean Planet For All

The European Commission's **Clean Planet for All** [5] is a vision released on November 2018, as part of the broader 2050 Long Term Strategy on climate change. The main areas covered by this plan are:

- Energy efficiency
- Deployment of renewable
- Clean, safe & connected Mobility
- Competitive industry and circular economy
- Infrastructure and interconnections
- Bio-economy and natural carbon sinks
- Remaining emissions carbon capture and storage

The level of complexity and commitment to transform this strategy into an executive plan is not indifferent, and the European Commission is aware of this. But ambitious results require the imposition of tough and structured intermediate targets on a broad portfolio of sectors, which, while seeming so far apart, are closely interlinked.

The EU has defined three main pillars to support the main goal of becoming carbon-neutral by 2050. The first pillar is spread the research, the most important engine in fighting climate changes. The joint research with corporate partnerships and community collaborations has, in fact, allowed the implementation of all the well-known innovative technologies. Looking to the future, it is the only tool that will allow to improve these technologies and to implement them on a large scale in an economically efficient way, making them affordable to everyone and letting possible the real change. The second pillar is innovation fund, fundamental in promoting research and disruptive ideas also in small business and start-ups. In details, it has the main objective to turns low-carbon technologies ideas in marketed ones. The fields of interest are renewable energy, energy storage, carbon capture use and storage and energy-intensive industries. Its key features are:

- volume of at least EUR 10 billion at current carbon prices;
- financed from the revenues of the EU Emissions Trading System;
- support of up to 60% of additional costs related to innovative technology;
- support of additional capital and operating costs (up to 10 years);
- first call expected for 2020 and regular calls up to 2030;

- comprehensive selection criteria and project development assistance.

The purpose of this long-term strategy is "not to set targets, but to create a vision and sense of direction". In fact, this strong sense of responsibility in imposing this plan demonstrates the European commitment to lead in global climate action and to present a vision that can lead to achieving net-zero greenhouse gas emissions by 2050 through a socially fair transition in a cost-efficient manner.

A European Strategy for Low-Emission Mobility

The European Commission's **Strategy for Low-Emission Mobility** [16] was released in July 2016 and has the major aim to keep pace with the requested changes, required globally, in terms low-emission mobility, ensuring, at the same time, competitiveness of the European Union and an increased level in the adoption of innovative and technological solutions boosting the interconnection between MS.

Different objectives are set:

- higher efficiency of the transport system;
- low-emission alternative energy for transport;
- low and zero emission vehicles.

The key field in which this strategy is focusing is the road transportation sector, which is responsible, alone, for over 70% of transport GHG and air pollution. The document calls, first of all, for an update of the regulatory framework. Moreover, to reach the objective highlighted above different actions are taken:

- The use of digital mobility solutions, fair pricing and the promotion of multimodality to improve the efficiency of the transport system.
- Scaling-up the use of low-carbon solutions and the roll-out of infrastructure for alternative fuels, rethinking the links between transport and energy systems, strengthening research and development.
- Standardization for electro-mobility, improvement in vehicle testing.

2030 framework for climate and energy policies

The European Commission's **2030 framework for climate and energy policies** [17] was adopted in October 2014 and revised in 2018.

This strategy established recommended targets to be respected by Member States, concerning different fields:

- Greenhouse gases emissions: a binding target to cut emissions in the EU by at least 40% below 1990 levels by 2030 is set.
- EU emissions trading system (ETS) sectors will have to cut emissions by 43%, compared to 2005.

- Non-ETS sectors will need to cut emissions by 30%, compared to 2005.
- Renewable: a binding renewable energy target for the EU for 2030 of at least 32% of final energy consumption.
- Energy efficiency: a headline target of at least 32.5% for energy efficiency to be achieved collectively by the EU in 2030.
- Adoption of integrated monitoring and reporting rules.
- Members States are required to adopt integrated national energy and climate plans (NECPs) and national long-term strategies.

2.3 Conclusions

The analysis made in this chapter has been used to outline all the main policies and instruments at European level used to combat climate change.

In the next chapter the analysis will move to the level of individual EU countries. For each MS the commitment to respect European constraints until 2020 will be analysed. In detail, attention will be paid to **Europe 2020 Strategy** and **EU ETS**.

2.4 Attachments

EU Climate Change policies (for the non-digital version see *Annex I*)

Chapter 3

Europe 2020 Strategy

A European strategy for smart, sustainable and inclusive growth

"Our short-term priority is a successful exit from the crisis. It will be tough for some time yet but we will get there. Significant progress has been made on dealing with bad banks, correcting the financial markets and recognising the need for strong policy coordination in the euro-zone.

To achieve a sustainable future, we must already look beyond the short term. Europe needs to get back on track. Then it must stay on track. That is the purpose of Europe 2020. It's about more jobs and better lives. It shows how Europe has the capability to deliver smart, sustainable and inclusive growth, to find the path to create new jobs and to offer a sense of direction to our societies.

The Commission is proposing five measurable EU targets for 2020 that will steer the process and be translated into national targets: for employment; for research and innovation; for climate change and energy; for education; and for combating poverty. They represent the direction we should take and will mean we can measure our success.

They are ambitious, but attainable. They are backed up by concrete proposals to make sure they are delivered. The flagship initiatives set out in this paper show how the EU can make a decisive contribution. We have powerful tools to hand in the shape of new economic governance, supported by the internal market, our budget, our trade and external economic policy and the disciplines and support of economic and monetary union.

The condition for success is a real ownership by European leaders and institutions. Our new agenda requires a coordinated European response, including with social partners and civil society. If we act together, then we can fight back and come out of the crisis stronger. We have the new tools and the new ambition. Now we need to make it happen."

José Manuel Barroso, Former President of the European Commission [20]

3.1 Background

Between 2007 and 2009 the U.S. financial crisis has brought down with it the growth of global economy. Major players as Greece, Ireland, Italy, Portugal and Spain were unable to keep pace with their public debt, generating precarious finances, high unemployment rate, failing to compete at the international level. Progressive, a loss of confidence toward the economic and political health of the European Union, has invested the thinking of citizens, firms and banks. Millions of people have lost their job, increasing their disappointment toward major institutions.

An immediate reaction was required to change structural weakness of the whole Union, combining the short-term priority to exit the crisis, to long-term strategy of sustainable growth.

3.2 Agenda of the Europe 2020 strategy

European 2020 strategy has been implemented to give a strong response to the urgent need of improvement and innovation that the global financial crisis has left. The main objective of this plan is to undertake a smart, inclusive and sustainable growth over ten years period, 2010-2020, regarding five main areas:

- Poverty and social exclusion
- Education
- Research & Development
- Employment
- Climate change & energy

These former targeted areas are strongly interrelated. Indeed, would not be possible to succeed in the optimization of one without the improvements of the others. Our analysis focuses on the exploitation of the **Climate change & energy targets** which are defined as:

- A reduction of at least 20% of Greenhouse gas emissions by 2020 compared to the 1990 levels;
- An improvement of energy efficiency of at least 20% over the whole territory;
- An increase of 20% of the share of renewal energy sources in the consumption of final energy.

To better cope with the synergies and the capabilities of each MS, these overall targets are then declined at the national level. Moreover, the European Commission, gave also a certain degree of freedom to the single Governments, letting possible to implement further policies or/and instruments to reach these internal goals if needed. In order to pursue this strategy, the only commitments of the participants is not enough. Another pillar is indispensable to deliver the expected results: a stronger economic governance based on country reporting.

In the following paragraphs are analysed the progress made, concerning climate change & energy targets, by each Member State and by European Union at the aggregate level.

3.2.1 Reduction of at least 20% of GHG by 2020 compared to the 1990 levels

In order to assess the compliance with this target, both at the aggregate (i.e. EU27 + UK) and at the national level, our analysis focused on the study of Eurostat database[1], concerning the levels of the major contributors of GHG emissions. Data regarding each Member State, looking for a period between 2011 to 2018, were compared with the respective 2020 targets (see Attachment *GHG Emissions* in 3.4).

The overall trend for Europe as a whole is positive, as shown in the Figure3.1. In 2018, the latest available data, the EU 27 + UK appears to show a reduction of 23% compared to the previous year.

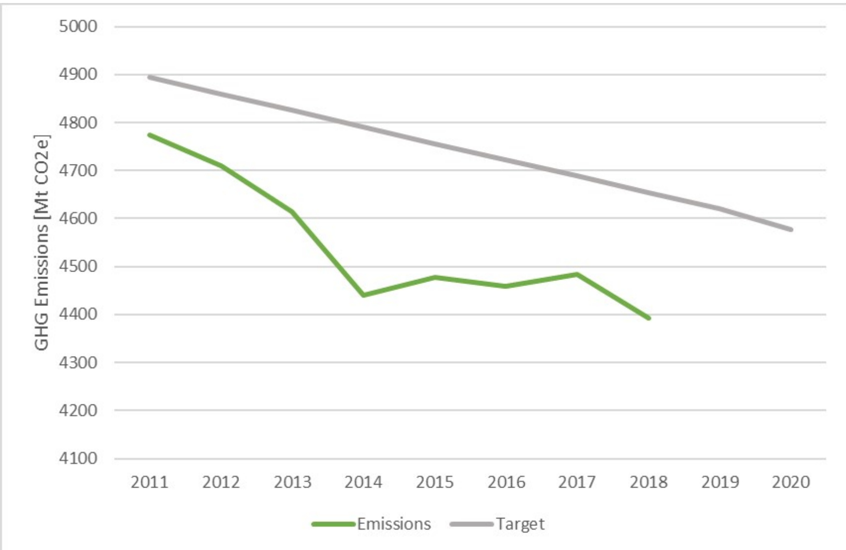

Figure 3.1: Overall GHG Emissions for EU 27 + UK

[1]for further information visit:
`https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_air_gge&lang=en`

However, dis-aggregating the data by single MS, it seems that not all countries have acted in compliance with the expected targets. In fact, the only nations which, at 2018, are on track are *Belgium, Denmark, Finland, France, Germany, Greece, Italy, Sweden* and *United Kingdom*. Instead, *Austria, Cyprus, Ireland, Netherlands, Portugal* and *Spain* are very far from the expected results, showing weak commitment. The remaining nations are in a dubious position, which needs to be deeper investigated. In fact, *Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia* and *Slovenia* show, at 2018, a negative trend despite the fact that the internal 2020 target was set to increase their emissions as an incentive for their economic growth. The latest result affects positively the overall target even if is symptom of a weak governance and an immature and not competitive internal economy.

From the Figure3.2 it is possible to see the above: some countries like *Belgium, Denmark, Finland* already reached the 2020 target in 2018; some countries like *Austria, Cyprus, Portugal* are very far from the 2020 target; other countries like *Bulgaria, Croatia, Czechia* show abnormal behaviour.

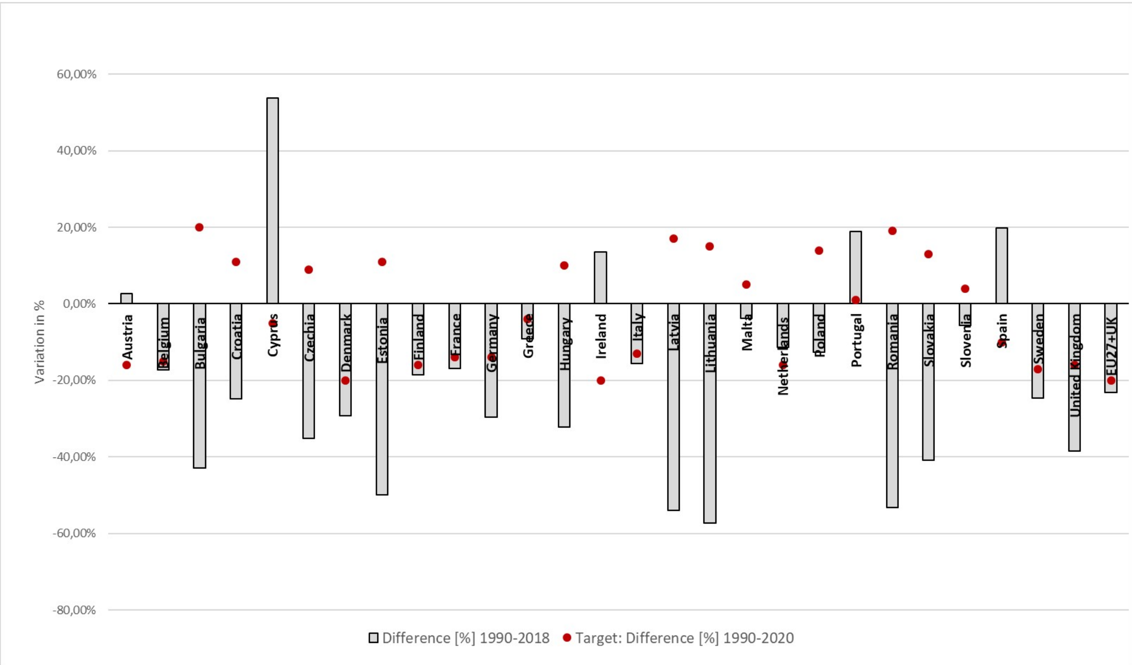

Figure 3.2: Comparison of emission change 1990-2018 and emission change target 1990-2020 for all EU MS

In-depth analysis of the ETS

Considering that the EU ETS covers around 45% of the EU's GHG, it has been decided to deepen this system as well.

The European Union Emissions Trading System [21] [22], is a cap and trade system for greenhouse gas (GHG) emissions of certain stationary installations and aircraft operators working in EU MS plus Iceland, Liechtenstein and Norway. It aims to reduce GHG emissions in a cost-effective and economically efficient way.

The system was first introduced in 2005. Its implementation has been divided up into distinct trading periods over time, known as phases:

- Phase 1 (2005 – 2007)
- Phase 2 (2008 – 2012)
- Phase 3 (2013 – 2020)
- Phase 4 (2021 – 2030)

The EU ETS started off with all 25 EU MS in phase 1, growing to 27 MS (EU 27) when Romania and Bulgaria joined the EU in 2007. From the start of phase 2 the EU ETS expanded to cover the entire European Economic Area (EEA) with Norway, Iceland and Liechtenstein. In phase 3 the EU ETS grew further with the addition of the largest stationary emitters in Croatia from January 2013, six months before official accession to the EU.

The first trading period of the EU ETS was a learning phase. The second trading period coincides with the first commitment period, of the Kyoto Protocol. In order to meet the given targets, the scope was widened, and a more ambitious cap was set. This trend was maintained in the third trading period, as more greenhouse gases and industries were added to the scheme in January 2013. In parallel, the cap decreases every year by a linear reduction factor.

- Phase 1: cap set for each MS, aggregate for the EU: 2.11 bln t CO2 eq p.a.
- Phase 2: cap set for each MS, aggregate for the EU: 2.09 bln t CO2 eq p.a.
- Phase 3: centralized EU-wide cap: 2.08 bln t CO2 eq in 2013, reduced annually by 1.74%.

Our analysis focused only on all stationary services, highlighted in the Table3.1, excluding the aviation sector.

Table 3.1: List of all the activities included in the EU ETS

#	**Type of activity**
1	Refining of mineral oil
2	Production of coke
3	Metal ore roasting or sintering
4	Production of pig iron or steel
5	Production or processing of ferrous metals
6	Production of primary aluminium
7	Production of secondary aluminium
8	Production or processing of non-ferrous metals
9	Production of cement clinker
10	Production of lime, or calcination of dolomite/magnesite
11	Manufacture of glass
12	Manufacture of ceramics
13	Manufacture of mineral wool
14	Production or processing of gypsum or plasterboard
15	Production of pulp
16	Production of paper or cardboard
17	Production of carbon black
18	Production of nitric acid
19	Production of ammonia
20	Production of bulk chemicals
21	Production of hydrogen and synthesis gas
22	Production of soda ash and sodium bicarbonate

Through the data provided by the European Environment Agency (EEA)[2], we have built four databases (see Attachment *EU ETS* in 3.4):

- **EU ETS - Compliance with targets**

  Starting from the third phase an EU-wide cap was established with a linear decrease factor of 1,74% with respect to the 2010 emissions level (midpoint of the 2008-2012 period). We analysed the total allocated allowances on all stationary installation for all MS during the three phases, verifying if each State has complied with the targets defined for each year. The 'most virtuous' countries have been highlighted in the Figure3.3, which have never (or almost) gone beyond the imposed targets, and are: *Cyprus, Czechia, Denmark, Finland, Germany, Greece, Ireland, Italy, Netherlands, Poland, Portugal, Slovakia, Slovenia, United Kingdom.*

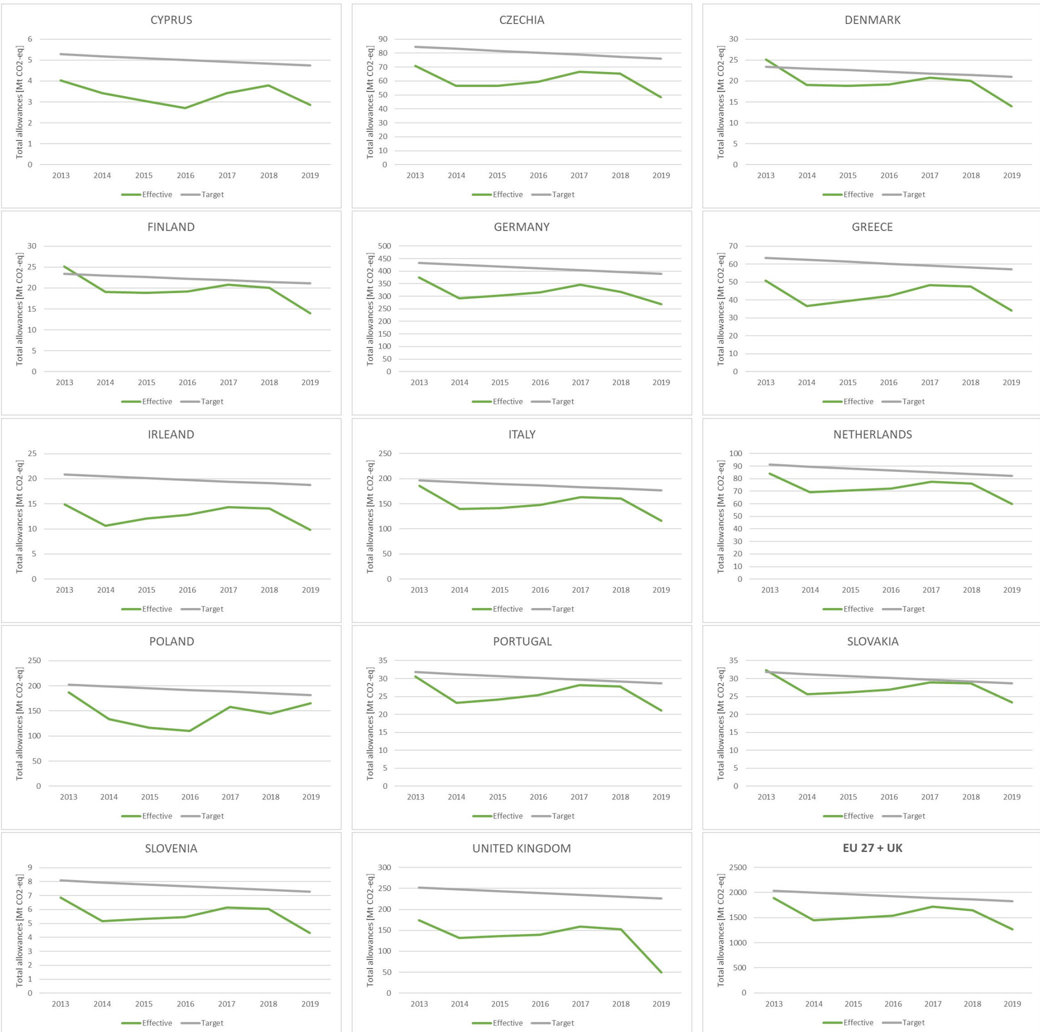

Figure 3.3: Total allocated allowances in all stationary services for all EU MS

[2]https://www.eea.europa.eu/data-and-maps/dashboards

- **EU ETS – Percentage of free allowances over total allocated allowances**

  We analysed the evolving, over the first three phases of trading, of the percentage of free allowances with respect to the total ones, emitted by each MS. During the first two phases almost, all countries emitted exclusively free allowances or even more than the auctioned ones, this because the first years of trading were a learning period in which the new system was tested and implemented. Starting from the third phase, instead, only sectors exposed to risks of carbon leakage received 100% of their allowances for free, the other sectors saw their free allocation reduced by 20% in 2013 and 70% by 2020. Countries which emitted at least for one year more free allowances than auctioned ones are: *Austria, Denmark, France, Spain*; However, the percentages of deviation from 100% are very small [Figure3.4]. Instead the ones which issued only free allowances in the third trading period (except for 2019) are: *Iceland, Liechtenstein, Norway* [Figure3.5]; precisely the countries outside the EU. It can be speculated that this is precisely a strategy to attract foreign workforce and encourage delocalisation from EU countries to these other countries.

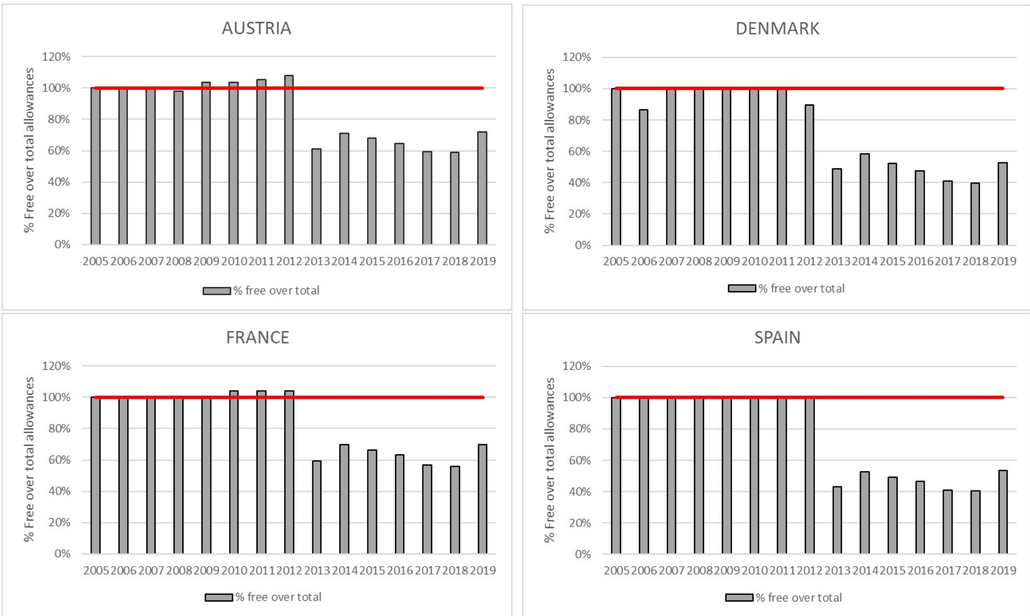

Figure 3.4: Countries whose free allowances are > total allowances for at least one year

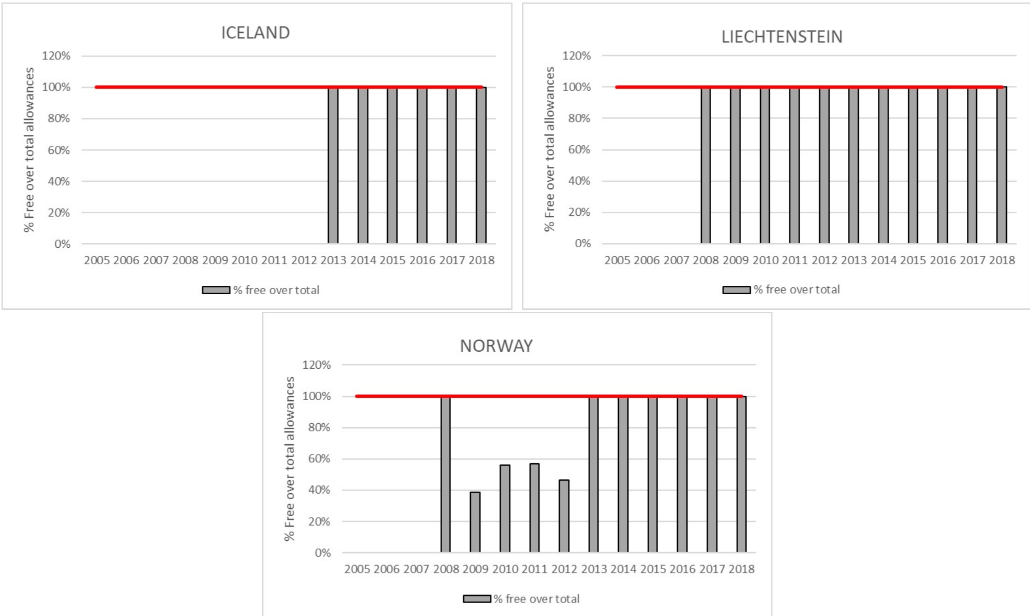

Figure 3.5: Countries which issued only free allowances in the third trading period (except for 2019)

- **EU ETS – Entities by size**

  The EU ETS classifies installations in three different monitoring categories:

  - **Category Zero**: annual emissions are equal to 0; this category usually refers to emissions from biomass.
  - **Category A**: it is divided into: **A1** average annual emissions are equal to or less than 25,000 tCO2 eq; **A2** average annual emissions between 25,000 and 50,000 tCO2 eq.
  - **Category B**: average annual emissions between 50,000 and 500,000 tCO2 eq.
  - **Category C**: average annual emissions are more than 500,000 tCO2 eq.

  This database shows the % of entities, belonging to a certain category, for each country, during the three periods considered. First of all, we tried to understand if this remain constant over the years. This hypothesis is confirmed, as demonstrated in Figure3.6, which shows that as time goes by, there have been no sudden increases in the number of entities belonging to one category compared to the others. A further analysis has been carried out to see which countries deviate significantly from the EU27 + UK values over the years. *Cyprus, Greece, Iceland, Luxembourg, Malta* have a higher percentage of Category C (high emissions) entities than other countries. *Denmark, Latvia, Liechtenstein, Lithuania*, instead, have a higher percentage of Category A (low emissions) entities than other countries [Figure3.7].

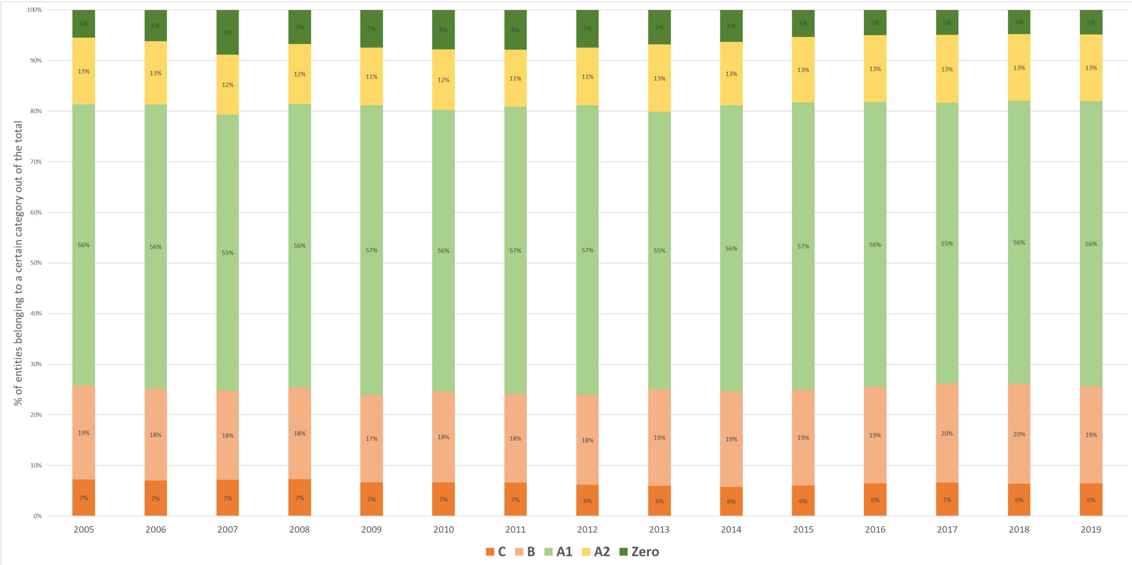

Figure 3.6: Distribution of installations according to categories in EU 27 + UK

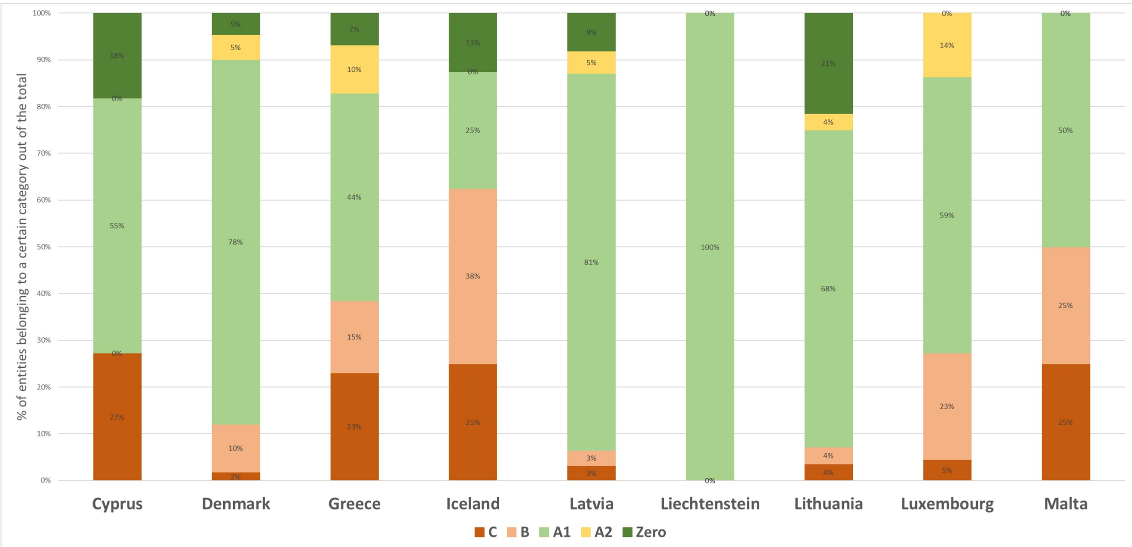

Figure 3.7: Distribution of installations according to categories for the year 2019

3.2.2 Improvement of energy efficiency of at least 20% over the whole territory

Energy Efficiency Directive (EED) [23] entered into force in December 2012 with the major aim to help European Union reaching the target of 20% energy efficiency by 2020. It established binding objectives at the European level, given flexibility to each Member State, as shown in Article 24, to adopt internal specific measures and policies to reach the goal.

Energy consumption indicator

The overall EU reduction target was **to not exceed 1483 Mtoe of primary energy or 1086 Mtoe in final energy consumption by 2020**.

In order to deeply understand the commitment of each MS, and their relative efforts to reach the common goal of energy efficiency, we examined data provided by the database Eurostat[3], regarding primary and final energy consumption (see Attachment *Energy efficiency directive* in 3.4):

- **Final energy consumption** is defined as the total energy consumed by end users ranging from households to industry and agriculture;
- **Primary energy consumption** is defined as the measure of the total energy demand of a nation (excluding all non-energy use of energy carriers), indeed, is the most accurate index to compare different countries to Europe 2020 target.

Data has been analysed considering a horizon of 20 years, from 2000 to 2020, but the effects of the policy can only be considered in the period 2013 - 2020, considering that it was implemented in December 2012. The available data refer up to 2018.

First of all, comparing the effective consumption of 2012 and the target set by 2020, for each member state, the difference in percentage was calculated. Then, we calculated the decreasing/increasing linear factor, dividing the percentage highlighted above for the number of years taken into consideration (8 years). Doing so, the effective consumption recorded by each MS was compared with the target related to each year (consumption of the previous year decreased by the linear factor).

In the period from 2000 to 2018, the EU has achieved a reduction in its total energy consumption by 4,17% in primary energy and 0,81% in final energy. While an encouraging trend was observed in the EU up until the year 2014, after that year the trend was subsequently reversed, as can be seen from the Figure3.8.

[3]Final energy consumption:
https://ec.europa.eu/eurostat/tgm/table.do?tab=table&plugin=1&language=en&pcode=t2020_34
Primary energy consumption:
https://ec.europa.eu/eurostat/databrowser/view/t2020_33/default/table?lang=en

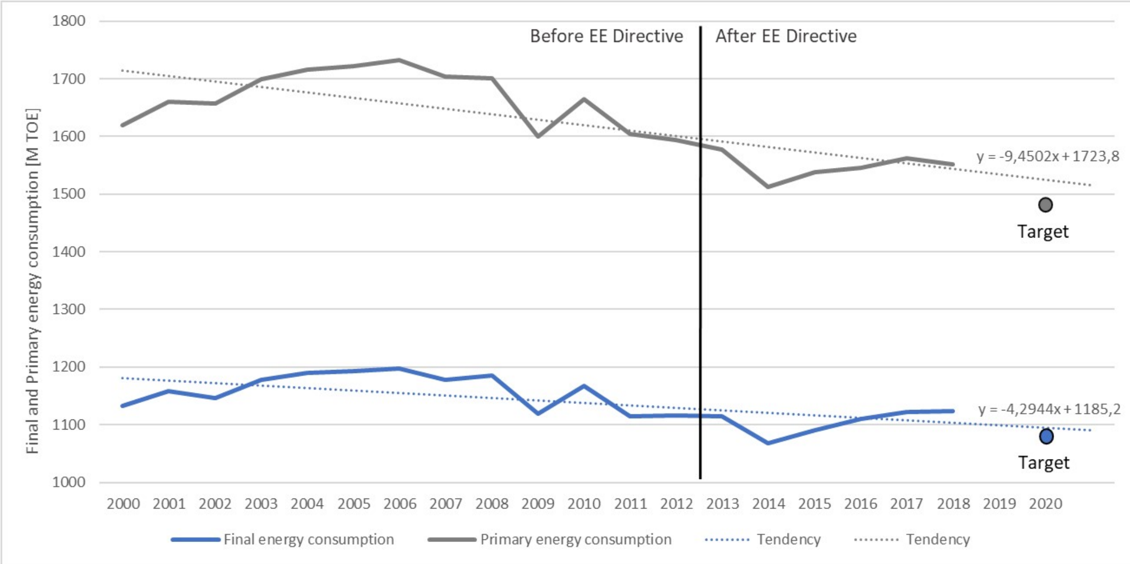

Figure 3.8: Final and primary energy consumption trend for EU 27 + UK

In 2014, the EU primary and final energy consumption registered the lowest value over the analysed period (1.512,4 and 1.067,58 Mtoe). From 2015 to 2017 the consumption increased again. In 2018 the primary energy consumption decreased with a reduction rate of 0.67% and the final energy consumption increased with a rate of 0,11%, but both remained still above the EU 2020 target. Building a trend line for the functions of final and primary energy consumption it is deduced in fact that neither of the two lines passes through the targets set for 2020. The actual gap to accomplish the target is 4,44% for the primary energy consumption and 3,39% for the final energy consumption.

Going into more detail, the moments before and after the entry into force of the Energy Efficiency Directive have been analysed separately in Figure3.9 and Figure3.10.

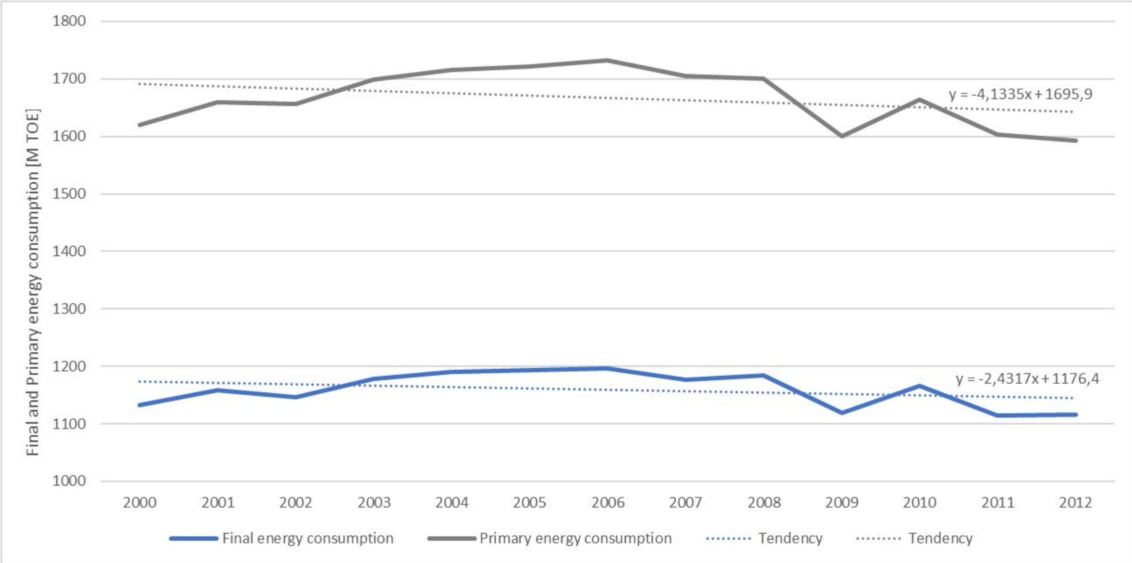

Figure 3.9: Final and primary energy consumption trend for EU 27 + UK before EED

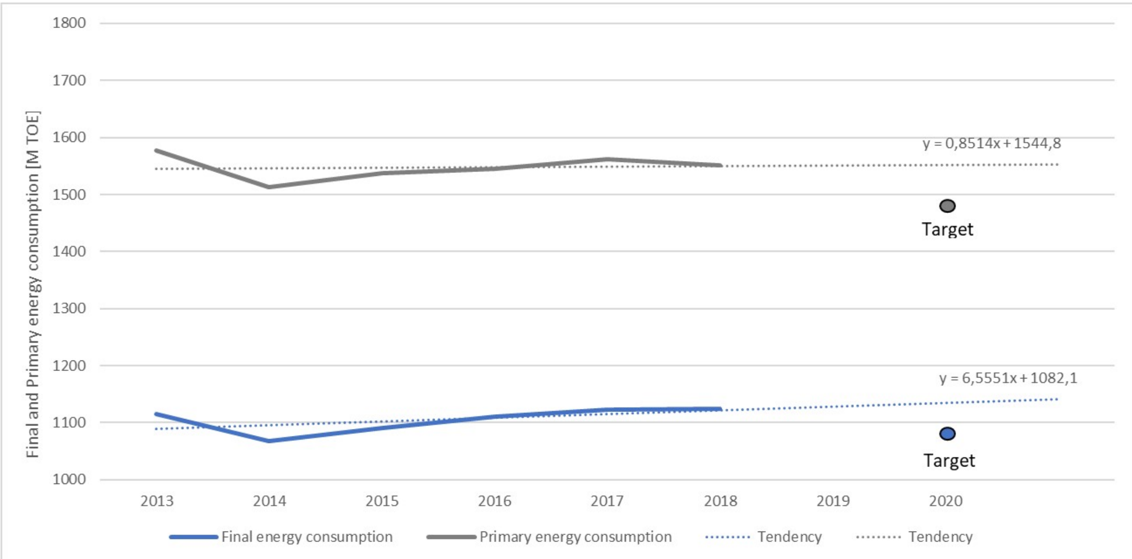

Figure 3.10: Final and primary energy consumption trend for EU 27 + UK after EED

It is even more evident here an anomalous trend in the consumption of final energy and primary energy, which leads to the hypothesis of the inefficiency of the directive. In fact, it is evident that in the period 2000-2012 in both functions the trend is decreasing, as opposed to the period 2013-2020 where the trend is increasing.

Focusing on final energy consumption analysing the different trends of each country, the only ones that can be considered virtuous (i.e. with final energy consumption over the years always lower than the targets set) are those whose emission targets imposed for 2020 are quantitatively lower than the emission levels of 2012. The countries in question are: *Croatia, Cyprus, Denmark, Finland, Greece, Italy, Latvia, Netherlands, Portugal, Romania, Slovenia, Spain.*

There is another consideration to be made: four MS (*Germany, France, Italy, United Kingdom*) consumed 54% of the total primary energy consumption [Figure3.11].

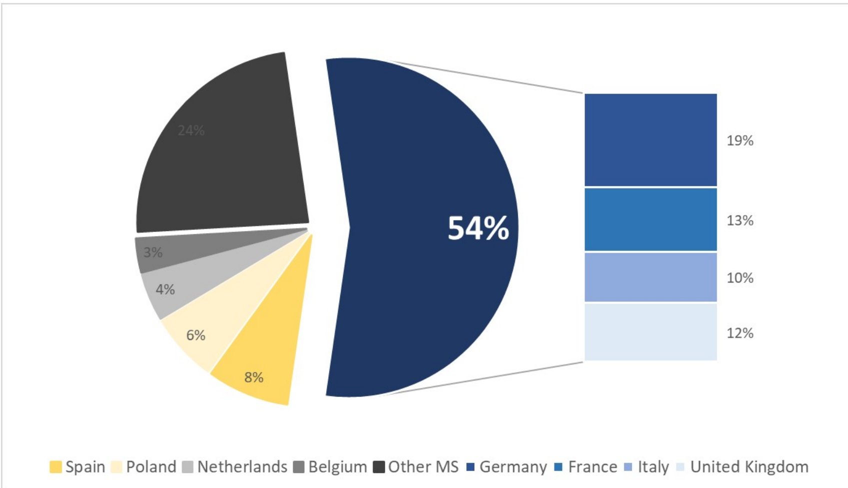

Figure 3.11: Shares of EU MS to final energy consumption in 2018

A detailed analysis of the performance of these four countries shows that, apart from *Italy*, the other countries do not meet the targets set. This is also evident from the trends of final energy consumption in Figure3.12.

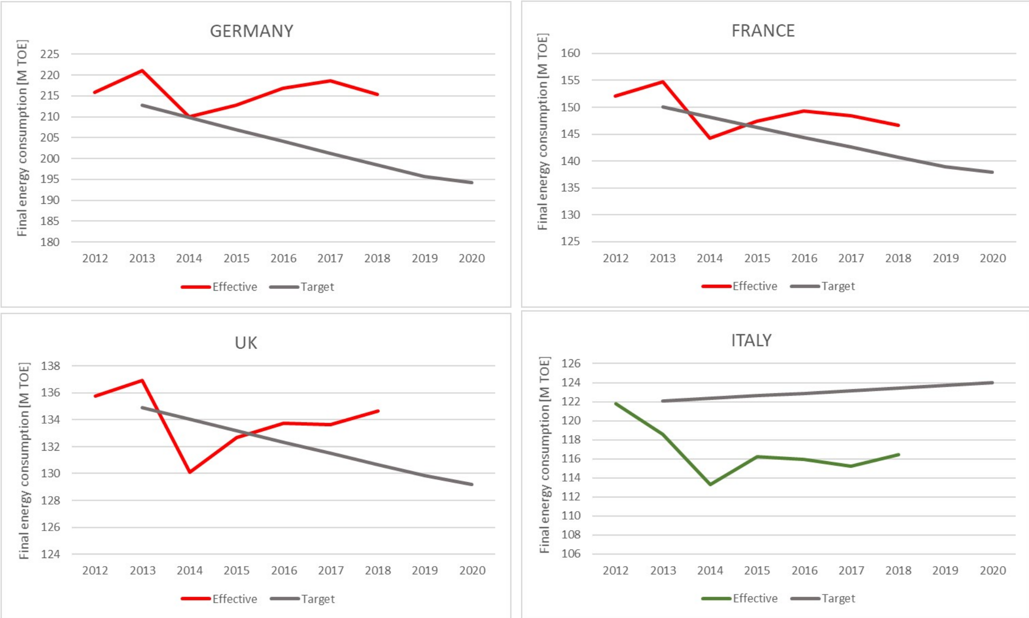

Figure 3.12: Final energy consumption trends

In all three countries from 2014 onward there is a growing trend that does not seem to stop for *United Kingdom*, unlike in *Germany and France* where from 2016 and 2017 the trend is reversed. It can therefore be said that the general trend in energy consumption in the EU 27 + UK, which starting from the application of the policy seems to be growing, depended heavily on the performance of the above-mentioned countries.

Energy intensity indicator

By studying country behaviour, taking into account the energy consumption indicator, we have realized that these trends can be influenced by country growth. A positive trend may be affected by GDP growth and not consider technological improvements and the positive impact of energy efficiency policies both at EU and national level.

In order to cope with this, we take into account another indicator, **energy** intensity, defined as the ratio between the energy consumption and GDP calculated for a calendar year (2010). Generally, the lower energy intensity, the higher competitiveness of country analysed. Looking at this energy indicator, it can be observed from Figure3.13 that energy intensity of EU 27 + UK declined from 159 to 118 Kilograms of Oil eq / thousand euro, with a reduction of 35%. From 2000 onward, there has been a continuous gradual decrease of this indicator, with the exception of 2003 and 2010 years.

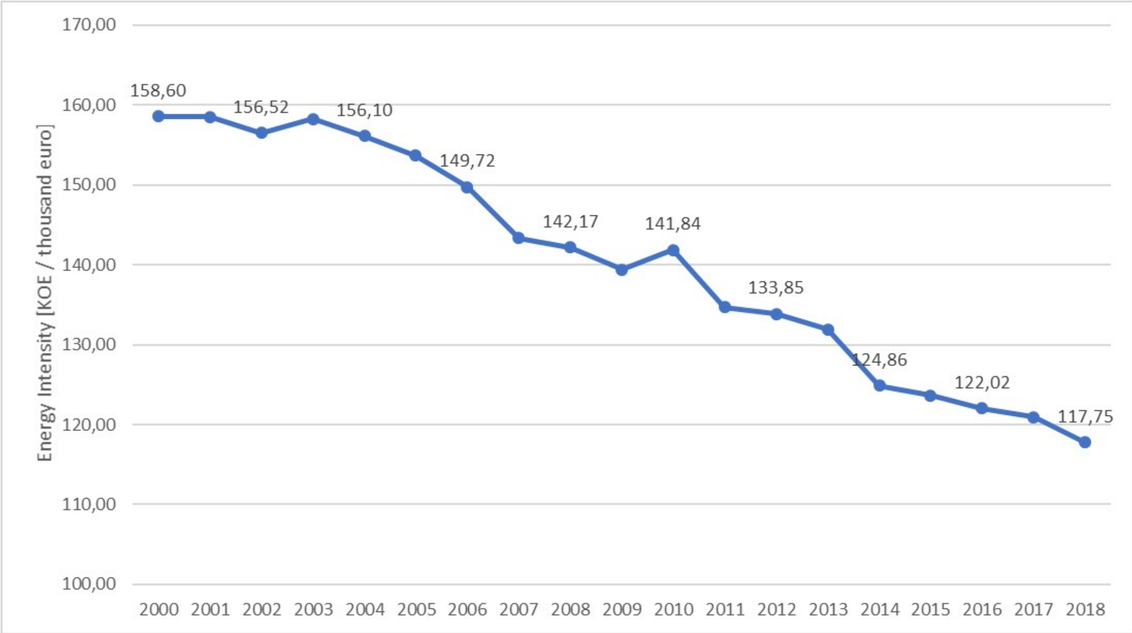

Figure 3.13: Energy intensity trend for EU 27 + UK

Even analysing the trends of the individual countries, it can be seen in Figure3.14 that, unlike the previous trends, which were all negative except for *Italy*, the trend is now always negative for all countries. This means that net of economic growth, the energy efficiency has improved over the years.

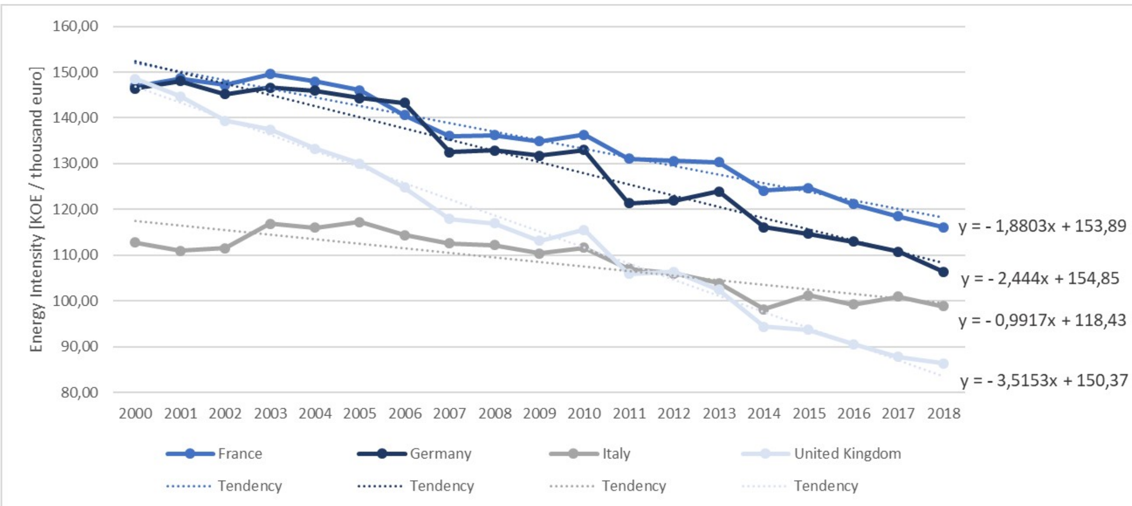

Figure 3.14: Energy intensity trends

3.2.3 Increase of at least 20% of the share of renewable energy sources in the consumption of final energy

The Europe 2020 strategy establishes that the share of renewable energy sources in final energy consumption should increase to 20%. In addition the directive on the promotion of the use of energy from renewable sources [24] sets mandatory national targets for the overall share of energy from renewable sources in gross final consumption of energy.

Renewable energy sources cover solar thermal and photovoltaic energy, hydro, wind, geothermal energy and all forms of biomass (including biological waste and liquid biofuels).

In order to deeply understand the commitment of each MS, and their relative efforts to reach the common goal, we examined data provided by the database Eurostat[4], regarding the share of renewable energy sources in the consumption of final energy (see Attachment *Share of energy from renewable sources* in 3.4).

In 2018, the share of energy from renewable sources in gross final energy consumption reached 18% in the EU, up from 17.5% in 2017 and almost double the share in 2005 (9,1%). By constructing the trendline one can notice that it passes through the target defined for 2020 [Figure3.15].

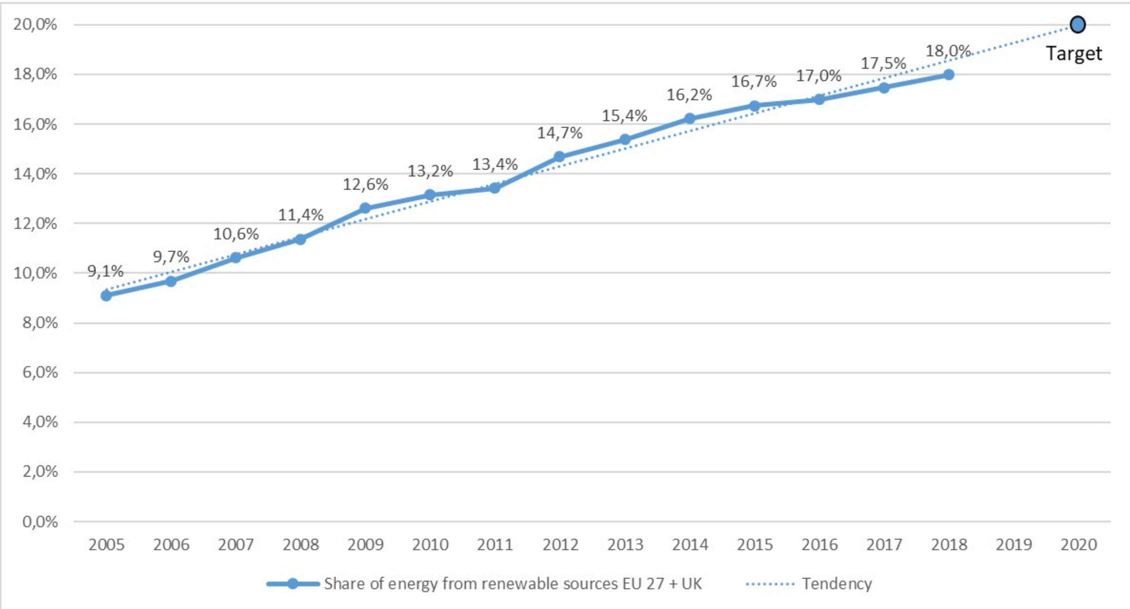

Figure 3.15: Share of energy from renewable sources for EU27 + UK

[4] https://ec.europa.eu/eurostat/web/energy/data/shares

As can be seen from the Figure3.16, among the 28 EU Member States, 12 MS have already reached a share equal to or above their national 2020 binding targets: *Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, Greece, Italy, Latvia, Lithuania* and *Sweden*.

Four MS are close to meet their targets (i.e. less than 1% point away): *Austria, Hungary, Portugal, Romania*. At the opposite end of the scale, *Netherlands* (6,6 point away), *France* (6,4 point away), *Ireland* (4,9 point away), *United Kingdom* (4 point away) and *Slovenia* (3,9 point away) are the furthest away from their targets.

Sweden had by far the highest share in 2018 with more than half (54,6%) of its energy coming from renewable sources and Netherlands the lowest (7,4%).

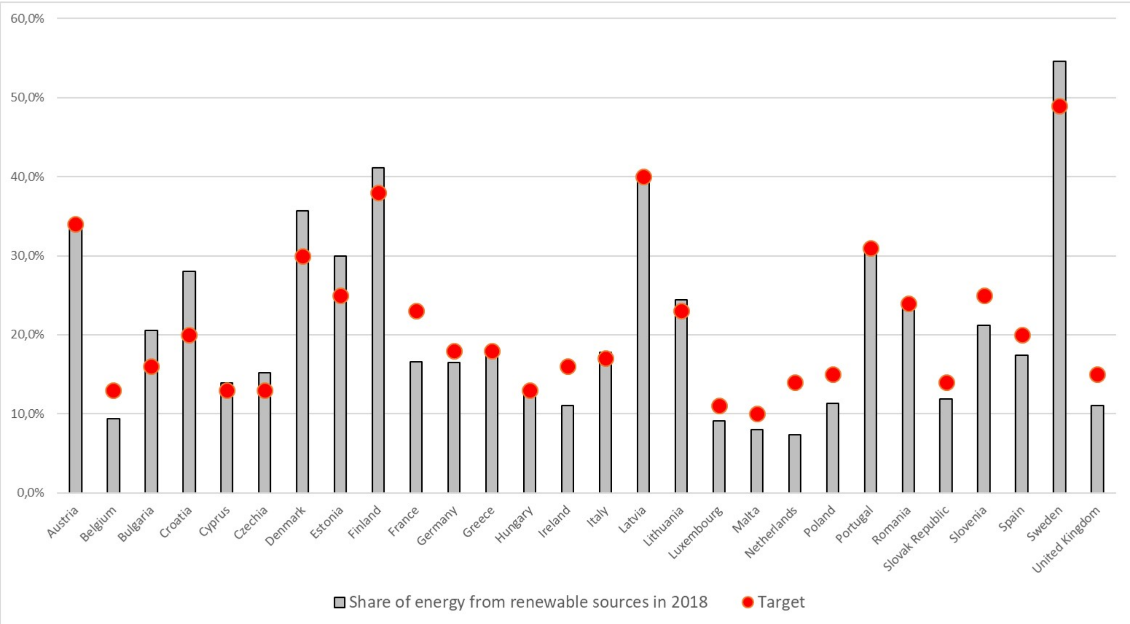

Figure 3.16: Comparison of share of energy from renewable sources in 2018 and national 2020 binding targets for all EU MS

3.3 Conclusions

This analysis exhibits that, at the aggregate level, European Union has demonstrated, in this current decade, a huge commitment in respecting 2020 Strategy targets and a strong capability to become sustainable also in the long term.

Dis-aggregating the whole picture, however, two different behaviours can be recognized. One cluster concerns countries with a strong and mature internal economy such as *Germany, France, Italy* and *United Kingdom*, the other includes the ones which joined later the EU coping with an expanding economy such as *Slovenia, Estonia, Romania* and *Cyprus*. This division reflects also the different level of internal commitment demonstrated toward this strategy. On one hand the most established states, although have been tackled very stringent targets, achieved the best results in terms of complying. On the other, the remaining countries did not always stick to the goals set, probably due to an unconsolidated economy.

Having this as historical data, the European Council already established, for the next decade 2020-2030, even more ambitious targets regarding climate change & energy with the **2030 framework for climate and energy policies** [17].

3.4 Attachments

1. GHG Emissions (for the non-digital version see *Annex II*)
2. EU ETS (for the non-digital version see *Annex III, IV, V*)
3. Energy efficiency directive (for the non-digital version see *Annex VI, VII, VIII*)
4. Share of energy from renewable sources (for the non-digital version see *Annex IX*)

Chapter 4

Impact analysis on small and medium-sized enterprises in the EU for the transportation sector

4.1 The economic effects of climate change and related mitigation policies

Recent studies propose that climate change directly affect economic variables, consequently interfering in the dynamics of markets. In literature, for example, several researches have shown evidences of how assets, sales and productivity could be influenced by extreme and unexpected weather conditions. In addition, the uncertainties and risks associated with the increasingly frequent occurrence of natural catastrophic events could led to an increase in the cost of equity capital for the most exposed geographical areas and sectors.

The paper Climate change and green transitions in an agent-based integrated assessment model [18], released in 2019, argue, under empirical basis, that the economic statistical equilibrium based on a sustainable green growth, if pursued, would lead to improved macroeconomic performances compared with the ones resulting from a carbon intensive economic structure.

The growing attention on this topic by the international scientific community has led governments, around the world, to define and implement policies and financial instruments to mitigate the climate effects that could damage, as above mentioned, even the economic balance of the world's most important powers. However, the imposition of these policies can also have, at least in the short term, negative effects on the performance of companies, and therefore this aspect should also be considered. In fact, if on the one hand they stimulate and encourage companies to innovate and invest in the creation of innovative processes with low environmental impact, they can also threaten and make entire sectors obsolete, also reducing the competitiveness necessary for growth.

This chapter analyses the consequences that some variables that express climatic data could have on specific economic indicators, taking into consideration the transportation sector. This research was conducted through the analysis and use of a dataset provided by the **Climate Finance Observatory** of the Polytechnic University of Milan. The Observatory is part of the Digital Innovation Observatories and wants to become the reference point for the study of climate finance and the impact of climate risk on companies and financial institutions. The dataset is based on more than 3,000,000 observations (3,083,560 precisely). Specifically, taking a sample of more than 300,000 SMEs present in the sector, **the results of operating revenues, total assets, non-current liabilities, current liabilities, a financial ratio (debt ratio) have been analysed** over a time interval of 10 years, from 2009 to 2018, **in relation to the occurrence of certain variations in the statistical variables of the model representing climate data.**

4.2 Transportation sector

The Global Industry Classification Standard (GICS[1]) classify the transport sector as a category of the broader industry sector and includes all companies and organizations that provide services and infrastructure for the movement of people, animals and goods such as delivery services, logistics, airlines, railways, air freight, marine and others. This sector is fundamental for the economy of a nation and for the life and well-being of its citizens. An efficient transport system with its adequate infrastructure, in fact, promotes tourism, reduces pollution, stimulates the growth and innovation of the country's economy and enhance internal and external competitiveness. However, this sector also has its weaknesses, in fact the performances of the companies within it depends heavily on some external agents. The most important is certainly the cost and supply of fuel, necessary for all the vehicles, very subjected to global dynamics, which therefore lead to its instability. In recent years the price of oil has increased dramatically, proving a decrease in profits and an increase in the cost structure of these companies. Other factors are labour supply and cost and governmental regulations. Regarding the latter, in the last few decades they have radically changed the structure of the entire sector, trying to promote and accelerate its conversion towards the total elimination of the use of fossil fuels.

In the Europe Union, according to the Statistical Pocketbook 2019 of the European Commission [19], this sector accounted for 5% of total Gross Value Added (GVA) in 2017, with a value of 675 bln€ (not considering own transport activities). The leading countries in the sector, per revenues, are Germany, the UK and France. Moreover, according to the Eurostat Labour Force Survey in the same year the sector employed about 12M of people.

[1]for further information visit:
`https://en.wikipedia.org/wiki/Global_Industry_Classification_Standard`

4.2.1 European policies on transportation

Due to its crucial importance and its dependence on fossil fuels, the transport sector has been the subject of several European Union Strategies, Directives and Regulations in the last 10 years. Latest strategy, A European Strategy for Low-Emission Mobility [16], has been released in July 2016 and has the aim to promote the transition of the Union towards a sustainable mobility, with a target of 100% carbon-free. The efficiency of infrastructures and the use of digital and cutting-edge solutions are also the theme of these objectives, since ensuring the competitiveness of Member States, promoting and encouraging the search for new solutions, is also a priority.

In order to achieve the objectives, several legislative actions have been taken by the European Commission to impose standards and obligations. Among these, Regulation setting CO_2 emission performance standards for new passenger cars and for new light commercial vehicles [11] and Clean and energy-efficient road transport vehicles [25] have been, respectively, emended in 2020 and in 2019. The former defines mandatory carbon dioxide emission limits per kilometer traveled, which all vehicle manufacturers must comply with for new passenger cars and new light commercial vehicles. The latter, instead, obliges companies to take into account, when purchasing on road vehicles , in support of production and distribution activities, the environmental consequences for the entire period of life or use of these.

Moreover, as previously explained in the second chapter, the transport sector has always been considered in a particular position with respect to whether or not to participate in the EU ETS. From 2008 a part of the sector, the aviation[2], entered into the European Emission Trading System, with a target reduction of GHG of 20% in 2020 and 40% in 2030, as part of the Paris Agreement objectives. To date, the road and maritime transport sectors are still excluded from the ETS, but Member States, thanks to the conclusions promoted at the 2014 European Council meeting, are mobilizing to try to extend the list of transport-related sectors within this scheme. For example Germany, in December 2019, approved the Fuel Emissions Trading Act (Brennstoffemissionshandelsgesetz – BEHG[3]), a national emission trading scheme, running in parallel with the European one. It establishes a fixed price on carbon, having the purpose to include, in the trading of GHG, also the emissions from fuels of transports and buildings. The starting price will be moderate: 25€/ton in 2021 to reach as high as 55€/ton in 2025. It is necessary to reach the targets for reducing emissions till 2030.

[2]According to GICS, Airlines sector is part of transportation sector.

[3]for further information visit: `https://www.bmu.de/fileadmin/Daten_BMU/Download_PDF/Gesetze/behg_en_bf.pdf`

4.3 Introduction to the model

Our analysis starts from the study of the specific database previously mentioned.

In this introductory part the variables that compose it are described. The dataset can be divided into two macro groups, a first cluster in which the economic variables are presented, and a second one that represents the description of statistical variables, modeling climate phenomena.

4.3.1 Economic variables

The economic variables are taken from the Orbis database which took into consideration inflation for the specific year considered. The following are used (the unit of measure is indicated in brackets):

- *Temp_index*: is the variable that refers uniquely to a given SME taken into consideration.
- *F_year*: represents the year to which the financial data and climate results refer. The time interval taken into consideration is 10 years from 2009 to 2018, for ease of finding reliable and consistent data.
- *Total_ass* [k€]: represents the economic variable total asset. For a company, an asset is defined as a tangible or intangible resource to which is associated a current economic value that may also increase in the future. At the accounting level, assets are recorded on the company's balance sheet and are acquired to increase their value and prestige. The possession of a particular type of asset, defined as innovative or rare to other companies, can bring a competitive advantage not indifferent to its owner. The sum of all the assets in possession of a company corresponds to the variable total assets, used in this model. At the accounting level are part of this variable: intellectual property, cash, credits, machinery, inventory, patents, equipment, copyrights, investments that mature in less than 90 days and more.
- *NC_liab* [k€]: refers to non-current liabilities variable present in the balance sheet of each company. This variable represents the long-term debts of a company i.e. with a maturity which exceeds 12 months. These liabilities are generally compared with cash flows to see whether the company will be able to meet these obligations over the long term. The more stable are cash flows, the more the company will be able to borrow in the long term, as it will have the confidence of its investors.
- *C_liab* [k€]: represents current liability variable. The difference with respect to the previous variable is that the debts and obligations are short-term and therefore fall due in less than 12 months. The variable with which current liabilities are related is generally the current assets, whose relationship is considered in order to understand whether the company will be able to pay these debts in the short term.

- *Op_revenue*: is associated to the operating revenues of each company taken into observation for a defined financial year. Operating revenues are defines as revenues obtained from the primary activities of the company itself, for example an on-line retail company will see as operating revenues the sales over the period of interest. This metric is often compared over the years in order to adjust the state of health of the company, as well as its growth. However, it must be remembered that the total revenues of a company are given by the sum of operating revenues and the ones obtained from non-primary business activities.

- *Sales* [k€]: represents the variable linked to the sales of a given company in a given year of interest.

- *Cost_sold* [k€]: refers to the economic variable cost of sales (COGS). This variable is defined as the sum of all direct costs relating to the acquisition of raw materials and production costs, such as direct labour costs, necessary to obtain the finished product sold by the company considered. Finally, it excludes the indirect costs associated with this product, such as distribution costs and others.

- *Total_assW01, NC_liabW01, C_liabW01, Op_revenueW01, SalesW01, Costs_soldW01* [k€]: are the same financial variables described above, but slightly modified. In fact, to make these variables more statistically consistent, the following process has been carried out. The observations that differ a lot from the minimum and maximum value present have been replaced with the data observed closer to this initial value.

- *SME_dummy*: is a binary variable that indicates whether the company defined by *temp_index* is a small or medium enterprise or not.

- *NACE_secL*: is the variable which indicates the statistical classification of economic activities in the European Community[4] and in the model it is “H”, with reference to the transport sector.

4.3.2 Climate statistical variables

The second macro group of variables present in the database represents the climatic and environmental phenomena. The following methodology has been used to construct these variables: a historical reference distribution has been built considering the daily temperatures observed from 1981 to 2010 for each region to which the companies considered into the model belong; starting from this, is defined an abnormal day from the climatic point of view, the one that deviates from the percentile, used as a threshold for that particular variable, of the probability distribution built on all the same days of the same month from 1981 to 2010.

[4]for further information visit:
`https://ec.europa.eu/competition/mergers/cases/index/nace_all.html`

Below are described in a broad way these variables:

- *cold_count & hot_count*: they are the climatic variables that represent the actual count of the days considered, respectively, cold and hot in reference of the *F_year* in the model, taking into consideration the geographic area to which the firm considered belongs. A day is therefore considered cold if it differs from the 10^{th} percentile of the probability distribution described above, while it is considered hot if it differs from the 90^{th} percentile of the same distribution.

- *cold_mean & hot_mean*: they represent the mean of the difference of temperature between respectively cold days and the 10^{th} percentile of the probability distribution and hot days and the 90^{th} percentile of the same distribution.

- *ex_cold_count & ex_hot_count*: which the extended name is extremely could count and extremely hot count. The difference with *could_count* and *hot_count* variables is the threshold considered to define a specific observed day hot or cold. The percentiles used for these two variables are respectively the 5^{th} for *ex_cold_count* and the 95^{th} for the *ex_hot_count*. For this reason these variables are considered more conservative.

- *ex_cold_mean & ex_hot_mean*: they represent the mean of the difference of temperature between respectively cold days and the 5^{th} percentile of the probability distribution and hot days and the 95^{th} percentile of the same distribution.

- *dd_hot & dd_cold*: they are variables which extended name is respectively degree days hot and cold. The variables are make up by multiplying, by region and by year, the number of hot or cold days and the respective average delta. The threshold considered are the same of could_count and hot_count.

- *dd_ex_hot & dd_ex_cold*: they are variables which extended name is respectively degree days hot and cold. The variables are make up by multiplying, by region and by year, the number of hot or cold days and the respective average delta. The threshold considered are the same of ex_could_count and ex_hot_count.

- *hot_year & cold_year*: they are Boolean variables which indicate if the year analysed is considered hot or cold with respect the ones considered normal and taken as baseline.

- *ex_hot_year & ex_cold_year*: they are Boolean variables which indicate if the year analysed is considered hot or cold with respect the ones considered normal and taken as baseline. For these variable the threshold considered is more conservative and it is the same of the other *ex_* variables.

- *rrm* [mm]: it represents the average rainfall level in a given area and in a given year.

- *qqm* [W/m^2]: it represent the average solar radiation in a given area and in a given year.
- *age*: maturity of the firm considered.

This model is used to conduct further analysis which is focused on the possible relationships between anomalous climatic phenomena and the reduction of economic profit variables, for SMEs in the transport sector. **In detail, in the next paragraphs, regression models will be structured and subsequently analysed in order to understand the relationship between some economic variables / financial ratios (operating revenues, total assets, non-current liabilities, current liabilities, debt ratio) and others related to climate change.**

4.4 Explanation of the multiple regression analysis output

First of all, let's explain the output of a multiple regression analysis in Figure4.1 and Figure4.2:

```
. regress

     Source a |     SS b        df c       MS d      Number of obs e  =
--------------+------------------------------        F(  ,      ) f   >
        Model |                                      Prob > F g       =
     Residual |                                      R-squared h      =
--------------+------------------------------        Adj R-squared i  =
        Total |                                      Root MSE j       =

------------------------------------------------------------------------------
              |    Coef.l  Std. Err.m     t n   P>|t| n    [95% Conf. Interval]o
--------------+---------------------------------------------------------------
              |
      _cons k |
------------------------------------------------------------------------------
```

Figure 4.1: Example of a linear regression model

```
------------------------------------------------------------------------------
              |    Coef.   Std. Err.      t     P>|t|                    Beta p
--------------+---------------------------------------------------------------
              |
        _cons |
------------------------------------------------------------------------------
```

Figure 4.2: Example of a linear regression model with standardized beta coefficients

Footnotes

a. This is the source of variance,*Model*, *Residual*, and *Total*. The Total Variance is partitioned into the variance which can be explained by the independent variables (*Model*) and the variance which is not explained by the independent variables (*Residual*).

b. These are the Sum of Squares associated with the three sources of variance, Total, Model and Residual.

- *SSTotal*: The total variability around the mean. $\Sigma(Y - Ybar)^2$.
- *SSResidual*: The sum of squared errors in prediction. $\Sigma(Y - Ypredicted)^2$.
- *SSModel*: The improvement in prediction by using the predicted value of Y over just using the mean of Y.

c. These are the degrees of freedom associated with the sources of variance. The total variance has N-1 degrees of freedom (*df*). The model degrees of freedom corresponds to the number of predictors (including the intercept) minus 1.

d. These are the Mean Squares, the Sum of Squares divided by their respective *df.*

e. This is the number of observations used in the regression analysis.

f. The F Value is the *MS Model* divided by the *MS Residual*, obtaining *F.*

g. This is the p-value associated with the F value. The p-value is compared to alpha level (in this case 0.05) and, if smaller, it means that the independent variables reliably predict the dependent variable. If the p-value were greater than alpha, it means that the group of independent variables do not show a significant relationship with the dependent variable. Note that the ability of each individual independent variable to predict the dependent variable is addressed in the table below.

h. R-square is the proportion of variance in the dependent variable which can be predicted from the independent variables.

i. Adjusted R-square indicates the variability of the dependent variable after taking into account the number of predictor variables in the model. When the number of observations is very large compared to the number of predictors, the value of R-square and adjusted R-square are closer.

j. *Root MSE* is the standard deviation of the error term, and is the square root of the *MS Residual* (or Error).

k. The variable *_cons* represents the constant, the height of the regression line when it crosses the Y axis.

l. *Coef.* tells you about the relationship between the independent variables and the dependent variable. These estimates tell the amount of increase in the dependent variable that would be predicted by a 1 unit increase in the predictor.

m. These are the standard errors associated with the coefficients.

n. These columns provide the t value and the p-value used in testing the null hypothesis that the coefficient is 0. Coefficients having p-values less than alpha are significant (i.e. you can reject the null hypothesis and say that the coefficient is significantly different from 0).

o. This shows a 95% confidence interval for the coefficient. This is very useful as it helps you understand how high and how low the actual population value of the parameter might be.

p. These coefficients are standardized regression coefficients. The beta coefficients are used by some researchers to compare the relative strength of the various predictors within the model. Because the beta coefficients are all measured in standard deviations, instead of the units of the variables, they can be compared to one another.

4.5 Operating revenue indicator

4.5.1 Model construction

To better understand which climate variables major represent the impact of environmental event over **operating revenues**, the following trial and error approach is used.

1. ***cold_ count* & *hot_ count* VS *cold_ mean* & *hot_ mean***

   The comparison of these two outputs shows that *cold_ count* and *hot_ count* better fit the model. In fact, using the *Adj R-squared* as discriminating, the first output has a value higher than the one of the second model. Consequently, *cold_ mean* and *hot_ mean* would not be considered in further regression models with operating revenue as dependent variable.

```
. regress Op_revenue cold_count hot_count

      Source |       SS           df       MS      Number of obs   = 1,744,112
-------------+----------------------------------   F(2, 1744109)   =   2985.31
       Model |  1.5733e+11         2  7.8664e+10   Prob > F        =    0.0000
    Residual |  4.5958e+13 1,744,109    26350300   R-squared       =    0.0034
-------------+----------------------------------   Adj R-squared   =    0.0034
       Total |  4.6115e+13 1,744,111  26440474.9   Root MSE        =    5133.3

------------------------------------------------------------------------------
  Op_revenue |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  cold_count |  -10.86578   .2423584   -44.83   0.000    -11.34079   -10.39076
   hot_count |  -14.36692   .1915245   -75.01   0.000     -14.7423   -13.99154
       _cons |   3751.696   42.94635    87.36   0.000     3667.522    3835.869
------------------------------------------------------------------------------
. regress Op_revenue cold_mean hot_mean

      Source |       SS           df       MS      Number of obs   = 1,744,112
-------------+----------------------------------   F(2, 1744109)   =   1352.02
       Model |  7.1386e+10         2  3.5693e+10   Prob > F        =    0.0000
    Residual |  4.6044e+13 1,744,109  26399575.7   R-squared       =    0.0015
-------------+----------------------------------   Adj R-squared   =    0.0015
       Total |  4.6115e+13 1,744,111  26440474.9   Root MSE        =    5138.1

------------------------------------------------------------------------------
  Op_revenue |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   cold_mean |   243.6615   7.076224    34.43   0.000     229.7923    257.5306
    hot_mean |   -227.122   9.719613   -23.37   0.000    -246.1721   -208.0719
       _cons |   1912.642   21.63528    88.40   0.000     1870.238    1955.047
------------------------------------------------------------------------------
```

2. ***ex_cold_count* & *ex_hot_count*** **VS** ***ex_cold_mean* & *ex_hot_mean***

   The comparison of the two outputs confirmed the robustness of the previous point. That is, the variable that represents the count, dense in the model better than its average, analysing both the *Adj R-squared* and the *Root MSE*.

```
. regress Op_revenue ex_cold_count ex_hot_count

      Source |       SS           df       MS      Number of obs   = 1,744,112
-------------+----------------------------------   F(2, 1744109)   =   3322.10
       Model |  1.7501e+11         2  8.7505e+10   Prob > F        =    0.0000
    Residual |  4.5940e+13 1,744,109    26340162   R-squared       =    0.0038
-------------+----------------------------------   Adj R-squared   =    0.0038
       Total |  4.6115e+13 1,744,111  26440474.9   Root MSE        =    5132.3

-------------------------------------------------------------------------------
   Op_revenue |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
ex_cold_count |  -11.47113   .2344528   -48.93   0.000    -11.93064   -11.01161
 ex_hot_count |  -13.93346    .171671   -81.16   0.000    -14.26993   -13.59699
        _cons |   3301.363   32.64179   101.14   0.000     3237.386     3365.34
-------------------------------------------------------------------------------
. regress Op_revenue ex_hot_mean ex_cold_mean

      Source |       SS           df       MS      Number of obs   = 1,744,112
-------------+----------------------------------   F(2, 1744109)   =   1250.59
       Model |  6.6038e+10         2  3.3019e+10   Prob > F        =    0.0000
    Residual |  4.6049e+13 1,744,109  26402641.9   R-squared       =    0.0014
-------------+----------------------------------   Adj R-squared   =    0.0014
       Total |  4.6115e+13 1,744,111  26440474.9   Root MSE        =    5138.4

------------------------------------------------------------------------------
  Op_revenue |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 ex_hot_mean |  -217.0151   10.29781   -21.07   0.000    -237.1984   -196.8317
ex_cold_mean |   257.0952   7.066027    36.38   0.000      243.246    270.9443
       _cons |   1844.054   21.82977    84.47   0.000     1801.269     1886.84
------------------------------------------------------------------------------
```

   Now, given the similar nature of count variables, the presence of one type in the final regression model excludes the other. To determine which of the two continue to take into account another comparison between the two was made but including the variable *age*.

3. ***cold_ count* & *hot_ count* VS *ex_ cold_ count* & *ex_ hot_ count***

Comparing the indicators, *ex_ cold_ count* and *ex_ hot_ count* better fit. In this case the accuracy of the data is higher, since the values considered for the two variables *ex_ hot_ count* and *ex_ cold_ count* only concern up to the 5th percentile and from the 95th percentile of the value distribution. Also analysing *Coef* of the variables *cold_ count* and *ex_ cold_ count*, it is evident that the impact on the dependent variable is greater in the second variable (-10.80 resp. -11.99), precisely because the measure of days considered to be cold is even stricter. On the contrary, the coefficient of the variables *hot_ count* and *ex_ hot_ count* is more or less the same.

```
. regress Op_revenue cold_count hot_count age
```

Source	SS	df	MS			
				Number of obs	=	1,730,145
				F(3, 1730141)	=	7651.25
Model	6.0302e+11	3	2.0101e+11	Prob > F	=	0.0000
Residual	4.5453e+13	1,730,141	26271227.1	R-squared	=	0.0131
				Adj R-squared	=	0.0131
Total	4.6056e+13	1,730,144	26619720.8	Root MSE	=	5125.5

Op_revenue	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
cold_count	-10.80317	.2426643	-44.52	0.000	-11.27879	-10.32756
hot_count	-12.39278	.1923896	-64.42	0.000	-12.76986	-12.01571
age	48.00998	.3685118	130.28	0.000	47.28771	48.73225
_cons	2957.784	43.44232	68.09	0.000	2872.639	3042.929

```
. regress Op_revenue ex_cold_count ex_hot_count age
```

Source	SS	df	MS			
				Number of obs	=	1,730,145
				F(3, 1730141)	=	7943.88
Model	6.2577e+11	3	2.0859e+11	Prob > F	=	0.0000
Residual	4.5430e+13	1,730,141	26258078.1	R-squared	=	0.0136
				Adj R-squared	=	0.0136
Total	4.6056e+13	1,730,144	26619720.8	Root MSE	=	5124.3

Op_revenue	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ex_cold_count	-11.99223	.2347041	-51.10	0.000	-12.45224	-11.53221
ex_hot_count	-12.22851	.1723575	-70.95	0.000	-12.56633	-11.8907
age	48.27826	.3683936	131.05	0.000	47.55622	49.0003
_cons	2611.169	33.10379	78.88	0.000	2546.287	2676.052

4. ***dd_ ex_ hot* & *dd_ ex_ cold* VS *dd_ hot* & *dd_ cold***

The second model better fits with the variables *dd_ ex_ hot* and *dd_ ex_ cold.*

```
. regress Op_revenue dd_cold dd_hot

      Source |       SS           df       MS      Number of obs   = 1,744,112
-------------+----------------------------------   F(2, 1744109)   =   2333.92
       Model |  1.2309e+11         2  6.1545e+10   Prob > F        =    0.0000
    Residual |  4.5992e+13 1,744,109  26369930.3   R-squared       =    0.0027
-------------+----------------------------------   Adj R-squared   =    0.0027
       Total |  4.6115e+13 1,744,111  26440474.9   Root MSE        =    5135.2

------------------------------------------------------------------------------
  Op_revenue |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     dd_cold |  -1.441542   .0577443   -24.96   0.000    -1.554719   -1.328365
      dd_hot |  -2.527524   .0371508   -68.03   0.000    -2.600338   -2.454709
       _cons |   1939.547   17.44554   111.18   0.000     1905.355     1973.74
------------------------------------------------------------------------------
```

```
. regress Op_revenue dd_ex_cold dd_ex_hot

      Source |       SS           df       MS      Number of obs   = 1,744,112
-------------+----------------------------------   F(2, 1744109)   =   2532.35
       Model |  1.3353e+11         2  6.6763e+10   Prob > F        =    0.0000
    Residual |  4.5982e+13 1,744,109  26363947.3   R-squared       =    0.0029
-------------+----------------------------------   Adj R-squared   =    0.0029
       Total |  4.6115e+13 1,744,111  26440474.9   Root MSE        =    5134.6

------------------------------------------------------------------------------
  Op_revenue |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  dd_ex_cold |  -2.188523   .0710616   -30.80   0.000    -2.327801   -2.049245
   dd_ex_hot |  -3.060337   .0435701   -70.24   0.000    -3.145733   -2.974941
       _cons |   1950.567   16.37822   119.10   0.000     1918.466     1982.667
------------------------------------------------------------------------------
```

Now the final choice between *ex_ hot_ count / ex_ cold_ count* and *dd_ ex_ hot / dd_ ex_ cold* must be taken, because both types of variables are the expression of the same phenomenon modeled mathematically in different way, so considering the final regression model, only one type has to be considered. Comparing the two outputs, *ex_ hot_ count* and *ex_ cold_ count* seem to better fit the model, so they are the type of variables which will be considered in the final model.

5. **Creation of the final model**

   Considering the final regression model, the independent variables taken into account are:

   - *C_liab* or *C_liabW01*, to verify the relationship between revenues and the debt capacity of a company;
   - *ex_hot_count* and *ex_cold_count*;
   - *ex_hot_year* and *ex_cold_year*, are also taken into account because Boolean modularization, which is different from the count distribution, could bring to different results not negligible in the final model;
   - *rrm*;
   - *qqm*;
   - *age*, in order to verify if there is a relationship with the maturity of the firms and its operating revenues results;

   We cannot consider the economic variables because they are too correlated to each other. A model is reliable when the correlation between variables does not exceed the value of 0.4.

We make a first test by inserting all the variables in the model and then we analyze the results.

It can be seen that the results of *Adj R-squared* and *Root MSE* are not so satisfying. The results are not so surprising considering that due to correlation problems we were obliged to exclude all economic variables.

```
. regress Op_revenue ex_cold_count ex_hot_count ex_cold_year ex_hot_year rrm qqm age
```

Source	SS	df	MS			
				Number of obs	=	1,584,758
				F(7, 1584750)	=	3790.03
Model	7.4401e+11	7	1.0629e+11	Prob > F	=	0.0000
Residual	4.4443e+13	1,584,750	28043856.4	R-squared	=	0.0165
				Adj R-squared	=	0.0165
Total	4.5187e+13	1,584,757	28513211.1	Root MSE	=	5295.6

Op_revenue	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ex_cold_count	-7.718149	.2679733	-28.80	0.000	-8.243367	-7.192931
ex_hot_count	-13.30573	.2231637	-59.62	0.000	-13.74312	-12.86834
ex_cold_year	-94.3322	47.14862	-2.00	0.045	-186.7419	-1.92253
ex_hot_year	282.1378	12.35119	22.84	0.000	257.9299	306.3458
rrm	.0145676	.0138914	1.05	0.294	-.0126591	.0417944
qqm	-9.30576	.1462555	-63.63	0.000	-9.592416	-9.019104
age	49.84735	.3936171	126.64	0.000	49.07587	50.61882
_cons	3728.821	41.07222	90.79	0.000	3648.321	3809.321

It is evident that is that the *Coef.* of the independent variables *ex_cold_year* and *ex_hot_year* are enormously greater than the others (respectively -94.33 and 282.14 as opposed to the other coefficients that have values in the range [-14;50]). Therefore the two variables mentioned above will not be included anymore. By eliminating the two variables *ex_hot_year* and *ex_cold_year*, in the new model *Adj R-squared* and *Root MSE* remain almost equal to those of the previous model.

```
. regress Op_revenue ex_cold_count ex_hot_count rrm qqm age
```

Source	SS	df	MS			
				Number of obs	=	1,584,758
				F(5, 1584752)	=	5199.70
Model	7.2934e+11	5	1.4587e+11	Prob > F	=	0.0000
Residual	4.4457e+13	1,584,752	28053079.3	R-squared	=	0.0161
				Adj R-squared	=	0.0161
Total	4.5187e+13	1,584,757	28513211.1	Root MSE	=	5296.5

Op_revenue	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ex_cold_count	-8.265838	.2586372	-31.96	0.000	-8.772758	-7.758918
ex_hot_count	-10.70448	.1918239	-55.80	0.000	-11.08045	-10.32852
rrm	.0124	.013893	0.89	0.372	-.0148297	.0396298
qqm	-9.479568	.1460393	-64.91	0.000	-9.7658	-9.193336
age	50.38184	.392987	128.20	0.000	49.6116	51.15208
_cons	3550.962	40.27671	88.16	0.000	3472.021	3629.903

The final model is found replacing the variable *Op_revenue* with *Op_revenueW01*, with a substantial improvement of reliability indicators.

4.5.2 Preliminary final model

In a preliminary analysis, the linear regression model used to assess the impact of environmental events on the **operating revenues** variable is illustrated in Figure4.3 and Figure4.4.

Let's examine the output from this regression analysis. The *R-squared* is 0.5930, meaning that approximately 59% of the variability of *Op_revenue* is accounted by the variables in the model. The coefficients for each of the variables indicates the amount of change one could expect in *Op_revenueW01* given a one-unit change in the value of that variable, given that all other variables in the model are held constant. Let's focus on the predictors, whether they are statistically significant and, if so, the direction of the relationship.

- The coefficients of *ex_cold_count* and *ex_hot_count* are both negative, as we would have expected. An increase of one cold day in a given area in a give year causes a decrease in revenues of 2.347 k€, whereas an increase of one hot day causes a decrease of 3.9 k€.
- The coefficient of *rrm* is positive, contrary to our expectations. A 1 mm increase in total rainfall for a given area in a given year causes an increase in revenues of 0.017 k€. Although the relationship is positive, this variable has the lowest *Coef.* of all and the impact on the reliability of the model is the smallest, with beta equal to 0.0026.
- The coefficient of *qqm* is negative, as we would have expected. An increase of 1 W/m^2 of average solar radiation for a given area in a given year causes a decrease in revenues of 4.635 k€.
- The coefficient of *age* is positive, which would indicate that the maturity of a firm has a positive influence on its revenues.
- The *_cons* is the predicted value when all the independent variables are equal to 0. Usually, the constant is not very interesting.

```
. regress Op_revenueW01 ex_cold_count ex_hot_count rrm qqm age

      Source |       SS           df       MS      Number of obs   = 1,584,758
-------------+----------------------------------   F(5, 1584752)   =  18923.69
       Model |  3.9923e+11         5  7.9846e+10   Prob > F        =    0.0000
    Residual |  6.6866e+12 1,584,752  4219360.18   R-squared       =    0.0563
-------------+----------------------------------   Adj R-squared   =    0.0563
       Total |  7.0859e+12 1,584,757  4471265.13   Root MSE        =    2054.1

------------------------------------------------------------------------------
Op_revenueW01|      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ex_cold_count|  -6.250718   .1003053   -62.32   0.000    -6.447313   -6.054123
 ex_hot_count|    -7.4665   .0743936  -100.36   0.000    -7.612309   -7.320691
          rrm|   .0174781    .005388     3.24   0.001     .0069178    .0280384
          qqm|  -6.254176   .0566373  -110.42   0.000    -6.365184   -6.143169
          age|   38.79707   .1524092   254.56   0.000     38.49835    39.09578
        _cons|    2540.22   15.62021   162.62   0.000     2509.605    2570.836
------------------------------------------------------------------------------
```

Figure 4.3: Linear regression model with operating revenue as dependent variable

```
. regress Op_revenueW01 ex_cold_count ex_hot_count rrm qqm age, beta

      Source |       SS           df       MS      Number of obs   = 1,584,758
-------------+----------------------------------   F(5, 1584752)   =  18923.69
       Model |  3.9923e+11         5  7.9846e+10   Prob > F        =    0.0000
    Residual |  6.6866e+12 1,584,752  4219360.18   R-squared       =    0.0563
-------------+----------------------------------   Adj R-squared   =    0.0563
       Total |  7.0859e+12 1,584,757  4471265.13   Root MSE        =    2054.1

------------------------------------------------------------------------------
Op_revenueW01|      Coef.   Std. Err.      t    P>|t|                     Beta
-------------+----------------------------------------------------------------
ex_cold_count|  -6.250718   .1003053   -62.32   0.000                -.0655819
 ex_hot_count|    -7.4665   .0743936  -100.36   0.000                -.1030849
          rrm|   .0174781    .005388     3.24   0.001                 .0026009
          qqm|  -6.254176   .0566373  -110.42   0.000                -.0901082
          age|   38.79707   .1524092   254.56   0.000                 .1980958
        _cons|    2540.22   15.62021   162.62   0.000                        .
------------------------------------------------------------------------------
```

Figure 4.4: Linear regression model with operating revenue as dependent variable, with st. beta coefficients

4.5.3 Regression diagnostics

There are four assumptions associated with a linear regression model (normality, linearity, homoscedasticity, independence); without verifying that the data have met the assumptions, the results may be misleading. In particular, we will consider the first two assumptions:

- **Normality**, the residuals should be normally distributed.
- **Linearity**, the relationships between the predictors and the outcome variable should be linear.

Normality

Let's check the normality of the residuals. As you can see from the graph below (Figure4.5), there is a massive deviation from normal.

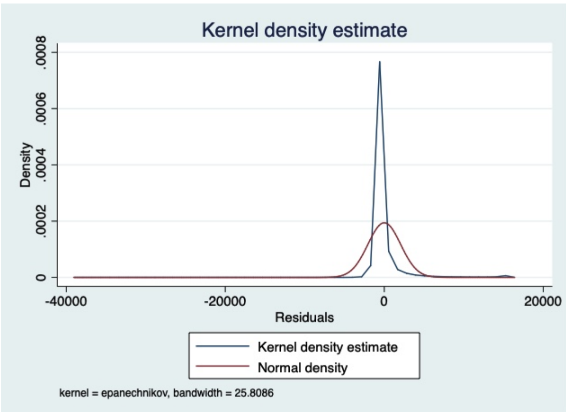

Figure 4.5: Kernel density plot for residuals with the normal option

A common cause of non-normally distributed residuals is non-normally distributed outcome and/or predictor variables. So, let us explore the distribution of our variables and how we might transform them to a more normal shape. **Logarithmic transformations** are a convenient means of transforming a highly skewed variable into one that is more approximately normal. Let's start by making histogram of the variables in the model (Figure4.6).

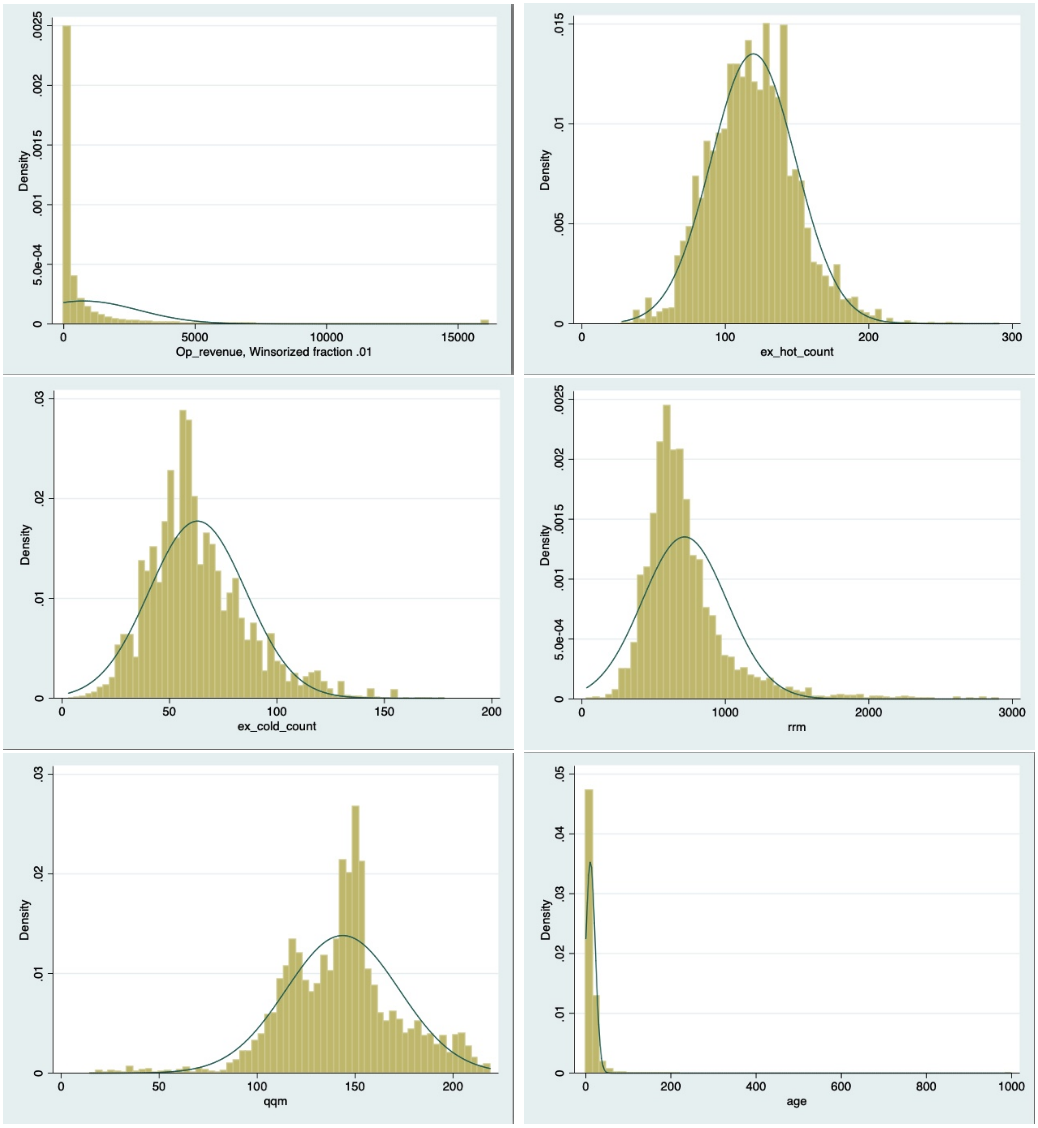

Figure 4.6: Histogram for all the variables in the model with normal option

In all of the graphs above the distribution looks skewed. In particular, the distribution of the variables *Op_ revenueW01* and *age* is particularly skewed to the right, while that of *ex_ cold_ count*, *ex_ hot_ count* and *rrm* is slightly skewed to the right, finally the one of *qqm* is slightly skewed to the left.

Let's see how the distribution of variables changes, turning them into logarithmic variables (Figure4.7).

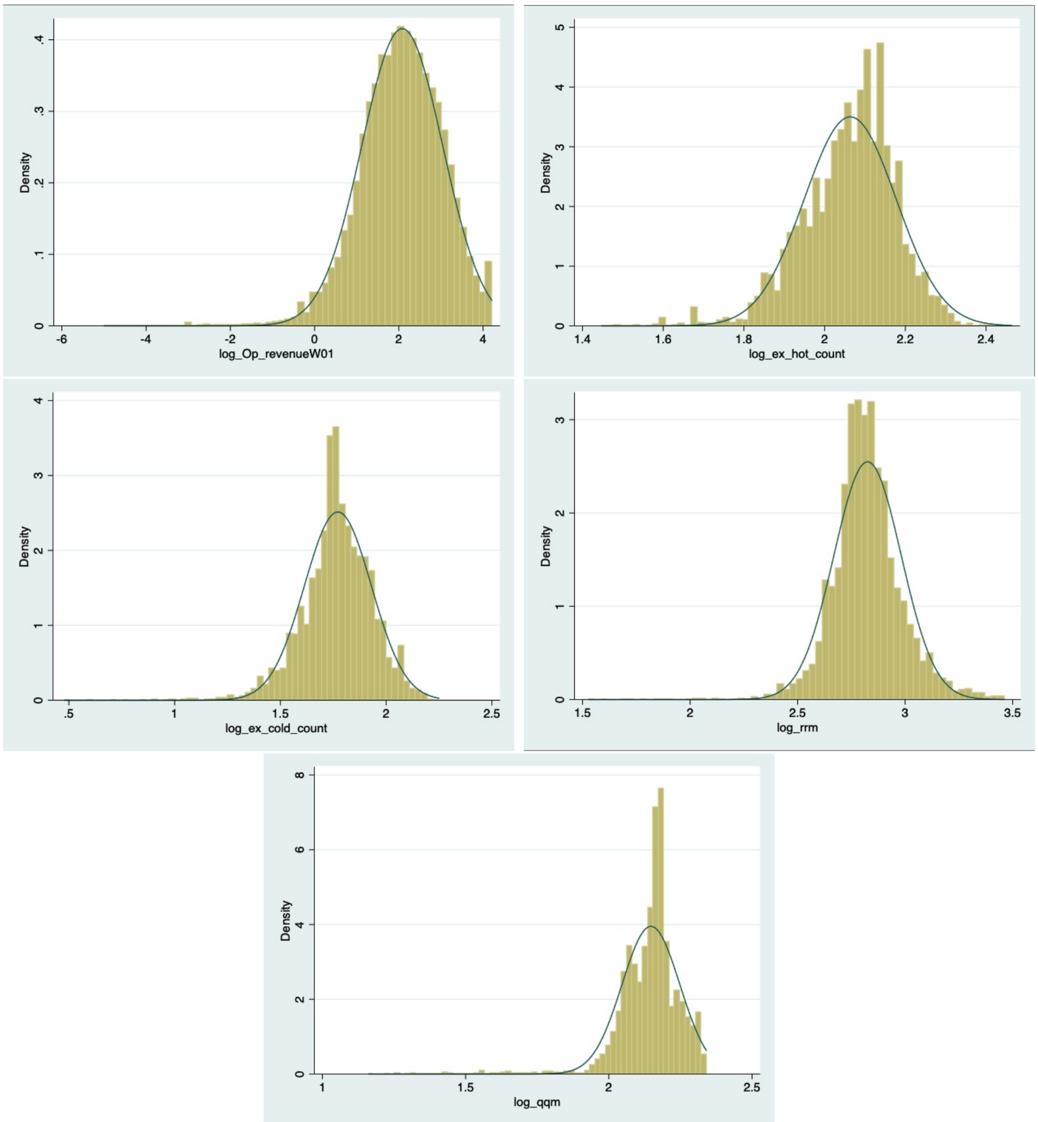

Figure 4.7: Histogram for all the log variables in the model with normal option

Now the distributions look definitely better. The only variable that does not have a logarithmic distribution is the variable *age*, because the values of this variable are adimensional and it would make no sense to perform a logarithmic function.

Rechecking the normality of residuals in the graph below (Figure4.8), now the pattern looks better with the two curves that tend to overlap, with a small deviation from normal.

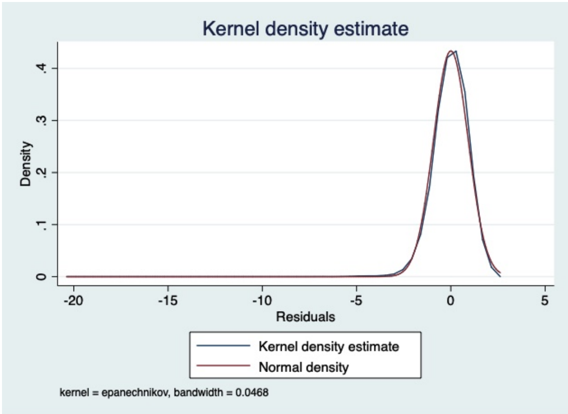

Figure 4.8: Kernel density plot for residuals with the normal option

Linearity

Linear regression needs the relationship between the independent and dependent variables to be linear. The linearity assumption can best be tested with scatter plots.

In the graphs below (Figure4.9) there isn't a clear non-linear pattern (such as a curved band or a big wave-shaped curve) so there is not the problem of non-linearity between variables.

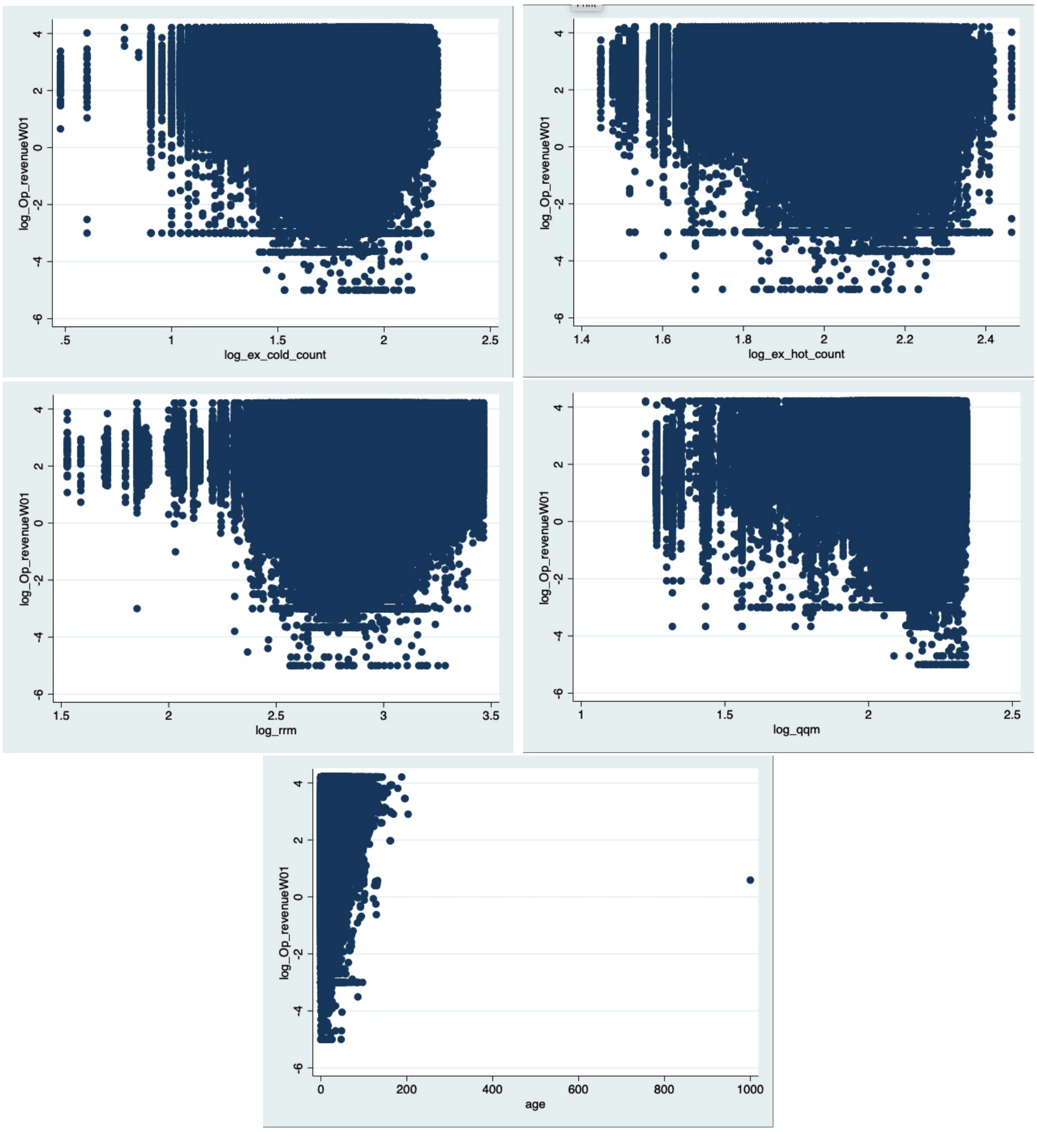

Figure 4.9: Scatter plots between the dependent variable and the predictors

Even if the scatter plots do not seem to show multi-collinearity, we need to do further checks to see if it is present or not. When there is a perfect linear relationship among the predictors, the estimates for a regression model cannot be computed. The term collinearity implies that two variables are near perfect linear combinations of one another; when more than two variables are involved it is often called multi-collinearity. Multi-collinearity may be tested with two central criteria:

- **Variance Inflation Factor (VIF)**. With VIF > 5 there is an indication that multi-collinearity may be present; with VIF > 10 there is certainly multi-collinearity among the variables. The VIFs look fine in the Figure4.10.

. vif

Variable	VIF	1/VIF
log_ex_col~t	1.80	0.555679
log_ex_hot~t	1.71	0.585249
log_qqm	1.14	0.874783
log_rrm	1.11	0.904908
age	1.02	0.981780
Mean VIF	1.36	

Figure 4.10: VIF command to check for multi-collinearity

- **Correlation matrix**. Among all independent variables the correlation coefficients need to be smaller than 0.4. Also the correlation coefficients look fine in the Figure4.11.

. correlate log_Op_revenueW01 log_ex_cold_count log_ex_hot_count log_rrm log_qqm age
(obs=1,488,853)

	log_O~01	log_ex..	log_ex..	log_rrm	log_qqm	age
log_Op_re~01	1.0000					
log_ex_col~t	-0.0355	1.0000				
log_ex_hot~t	-0.0923	-0.6248	1.0000			
log_rrm	0.0613	0.1702	-0.2179	1.0000		
log_qqm	-0.0645	0.2577	-0.0651	-0.1731	1.0000	
age	0.2283	0.0621	-0.1187	0.0667	0.0375	1.0000

Figure 4.11: Matrix indicating the correlations among all variables

4.5.4 Final model

The final linear regression model used to assess the impact of environmental events on the **operating revenues** variable is illustrated in Figure4.12 and Figure4.13.

Let's examine the output from this regression analysis. The *R-squared* is 0.0729, meaning that approximately 7% of the variability of *log_Op_revenueW01* is accounted by the variables in the model. Now both model reliability indicators have improved, compared to the preliminary analysis model: *Adj R-squared* has increased (0.0729 versus 0.0563) and *Root MSE* has decreased significantly (0.92007 versus 2054.1), due to much smaller coefficients. Also in this final model the accuracy indicators of the model are rather low, but we should not be surprised about this, being only climatic variables that cannot fully explain the trend of the dependent variable operating revenue. Let's focus on the predictors, whether they are statistically significant and, if so, the direction of the relationship.

- The coefficients of *log_ex_cold_count* and *log_ex_hot_count* are both negative, as we would have expected. An increase of 1% in ex_cold_count causes a decrease in revenues of 0.83%[5], whereas an increase of 1% in ex_hot_count causes a decrease of 1.21%[6].
- The coefficient of *log_rrm* is positive. A 1% increase in the total rainfall for a given area in a given year causes an increase in revenues of 0.18%[7].
- The coefficient of *log_qqm* is negative, as we would expect. An increase of 1% in the average solar radiation for a given area in a given year causes a decrease in revenues of 0.37%[8].
- The coefficient of *age* is positive, which would indicate that the maturity of a firm has a positive influence on its revenues; a company one year older increases its revenues by 1.04%[9].
- The *_cons* is the predicted value when all the independent variables are equal to 0. Usually, the constant is not very interesting.

[5] the result comes out by this calculation: $(1 - 10^{log(1.01)*-0.8407568}) * 100$
[6] the result comes out by this calculation: $(1 - 10^{log(1.01)*-1.225279}) * 100$
[7] the result comes out by this calculation: $(10^{log(1.01)*0.0039996} - 1) * 100$
[8] the result comes out by this calculation: $(1 - 10^{log(1.01)*-0.0141205}) * 100$
[9] the result comes out by this calculation: $(10^{0.+0191186} - 1) * 100$

```
. regress log_Op_revenueW01 log_ex_cold_count log_ex_hot_count log_rrm log_qqm age
```

Source	SS	df	MS
Model	99113.6019	5	19822.7204
Residual	1260361.62	1,488,847	.846535352
Total	1359475.22	1,488,852	.913102995

Number of obs	=	1,488,853
F(5, 1488847)	=	23416.29
Prob > F	=	0.0000
R-squared	=	0.0729
Adj R-squared	=	0.0729
Root MSE	=	.92007

log_Op_revenueW01	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
log_ex_cold_count	-.8407568	.0065808	-127.76	0.000	-.853655	-.8278586
log_ex_hot_count	-1.225279	.0085987	-142.50	0.000	-1.242132	-1.208426
log_rrm	.1796654	.0049026	36.65	0.000	.1700566	.1892742
log_qqm	-.3714382	.0074426	-49.91	0.000	-.3860254	-.356851
age	.0191186	.0000696	274.76	0.000	.0189823	.019255
_cons	6.202658	.0332153	186.74	0.000	6.137557	6.267759

Figure 4.12: Linear regression model with operating revenue as dependent variable

```
. regress log_Op_revenueW01 log_ex_cold_count log_ex_hot_count log_rrm log_qqm age, beta
```

Source	SS	df	MS
Model	99113.6019	5	19822.7204
Residual	1260361.62	1,488,847	.846535352
Total	1359475.22	1,488,852	.913102995

Number of obs	=	1,488,853
F(5, 1488847)	=	23416.29
Prob > F	=	0.0000
R-squared	=	0.0729
Adj R-squared	=	0.0729
Root MSE	=	.92007

log_Op_revenueW01	Coef.	Std. Err.	t	P>|t|	Beta
log_ex_cold_count	-.8407568	.0065808	-127.76	0.000	-.1352429
log_ex_hot_count	-1.225279	.0085987	-142.50	0.000	-.146984
log_rrm	.1796654	.0049026	36.65	0.000	.0304002
log_qqm	-.3714382	.0074426	-49.91	0.000	-.0421065
age	.0191186	.0000696	274.76	0.000	.2188178
_cons	6.202658	.0332153	186.74	0.000	.

Figure 4.13: Linear regression model with operating revenue as dependent variable, with st. beta coefficients

4.6 Total asset indicator

4.6.1 Model construction

Regarding the choice of environmental variables to adopt in the model with total asset as dependent variable, we will repeat the trial and error approach used in the previous model.

1. ***cold_count* & *hot_count* VS *cold_mean* & *hot_mean***

   The comparison of these two outputs shows that *cold_count* and *hot_count* better fit the model. In fact, using the *Adj R-squared* as discriminating, the first output has a value higher than the one of the second model. Consequently, *cold_mean* and *hot_mean* would not be considered in further regression models with total asset as dependent variable.

```
. regress Total_assW01 cold_count hot_count

      Source |       SS           df       MS      Number of obs   = 1,832,985
-------------+----------------------------------   F(2, 1832982)   =   7406.56
       Model |  6.0334e+10         2  3.0167e+10   Prob > F        =    0.0000
    Residual |  7.4658e+12 1,832,982  4073010.2    R-squared       =    0.0080
-------------+----------------------------------   Adj R-squared   =    0.0080
       Total |  7.5261e+12 1,832,984  4105921.47   Root MSE        =    2018.2

------------------------------------------------------------------------------
Total_assW01 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  cold_count |  -6.007487   .0917039   -65.51   0.000    -6.187224   -5.827751
   hot_count |  -8.516295   .0730887  -116.52   0.000    -8.659546   -8.373044
       _cons |   2265.498   16.31107   138.89   0.000     2233.529    2297.467
------------------------------------------------------------------------------

. regress Total_assW01 cold_mean hot_mean

      Source |       SS           df       MS      Number of obs   = 1,832,985
-------------+----------------------------------   F(2, 1832982)   =   5091.55
       Model |  4.1580e+10         2  2.0790e+10   Prob > F        =    0.0000
    Residual |  7.4845e+12 1,832,982  4083241.56   R-squared       =    0.0055
-------------+----------------------------------   Adj R-squared   =    0.0055
       Total |  7.5261e+12 1,832,984  4105921.47   Root MSE        =    2020.7

------------------------------------------------------------------------------
Total_assW01 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   cold_mean |   163.9091   2.720404    60.25   0.000     158.5772     169.241
    hot_mean |  -193.2748   3.714991   -52.03   0.000    -200.5561   -185.9936
       _cons |   1379.447   8.199455   168.24   0.000     1363.376    1395.517
------------------------------------------------------------------------------
```

2. ***ex_ cold_ count* & *ex_ hot_ count* VS *ex_ cold_ mean* & *ex_ hot_ mean***

   The comparison of the two outputs confirmed that the variables that represent the count dense in the model better than its average, analysing both the *Adj R-squared* and the *Root MSE*.

```
. regress Total_assW01 ex_cold_count ex_hot_count

      Source |       SS           df       MS      Number of obs   = 1,832,985
-------------+----------------------------------   F(2, 1832982)   =   7956.40
       Model |  6.4774e+10         2  3.2387e+10   Prob > F        =    0.0000
    Residual |  7.4613e+12 1,832,982  4070587.65   R-squared       =    0.0086
-------------+----------------------------------   Adj R-squared   =    0.0086
       Total |  7.5261e+12 1,832,984  4105921.47   Root MSE        =    2017.6

------------------------------------------------------------------------------
Total_assW01 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ex_cold_count |  -5.928701   .0886065   -66.91   0.000    -6.102367   -5.755035
 ex_hot_count |  -8.131722   .0654587  -124.23   0.000    -8.260018   -8.003425
        _cons |   1962.259   12.36644   158.68   0.000     1938.021    1986.497
------------------------------------------------------------------------------

. regress Total_assW01 ex_cold_mean ex_hot_mean

      Source |       SS           df       MS      Number of obs   = 1,832,985
-------------+----------------------------------   F(2, 1832982)   =   4533.80
       Model |  3.7048e+10         2  1.8524e+10   Prob > F        =    0.0000
    Residual |  7.4890e+12 1,832,982  4085714.28   R-squared       =    0.0049
-------------+----------------------------------   Adj R-squared   =    0.0049
       Total |  7.5261e+12 1,832,984  4105921.47   Root MSE        =    2021.3

------------------------------------------------------------------------------
Total_assW01 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ex_cold_mean |   163.7002   2.699758    60.64   0.000     158.4088    168.9916
 ex_hot_mean |  -197.5158   3.933033   -50.22   0.000    -205.2244   -189.8072
       _cons |   1332.224    8.28359   160.83   0.000     1315.988    1348.459
------------------------------------------------------------------------------
```

   Now, given the similar nature of count variables, the presence of one type in the final regression model excludes the other. To determine which of the two continue to take into account another comparison between the two was made but including the variable *age*.

3. ***cold_ count* & *hot_ count* VS *ex_ cold_ count* & *ex_ hot_ count***

Comparing the indicators, *ex_ cold_ count* and *ex_ hot_ count* better fit. In this case the accuracy of the data is higher, since the values considered for the two variables *ex_ hot_ count* and *ex_ cold_ count* only concern up to the 5th percentile and from the 95th percentile of the value distribution.

```
. regress Total_assW01 cold_count hot_count age

      Source |       SS           df       MS      Number of obs   = 1,819,742
-------------+----------------------------------   F(3, 1819738)   =  22296.82
       Model |  2.6502e+11         3  8.8341e+10   Prob > F        =    0.0000
    Residual |  7.2099e+12 1,819,738  3962050.22   R-squared       =    0.0355
-------------+----------------------------------   Adj R-squared   =    0.0355
       Total |  7.4749e+12 1,819,741  4107681.63   Root MSE        =    1990.5

------------------------------------------------------------------------------
Total_assW01 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  cold_count |  -5.778734   .0906743   -63.73   0.000    -5.956453   -5.601016
   hot_count |  -7.054251   .0725494   -97.23   0.000    -7.196446   -6.912057
         age |   30.03864   .1319897   227.58   0.000     29.77994    30.29733
       _cons |    1712.21   16.30937   104.98   0.000     1680.244    1744.175
------------------------------------------------------------------------------

. regress Total_assW01 ex_cold_count ex_hot_count age

      Source |       SS           df       MS      Number of obs   = 1,819,742
-------------+----------------------------------   F(3, 1819738)   =  22787.27
       Model |  2.7064e+11         3  9.0214e+10   Prob > F        =    0.0000
    Residual |  7.2043e+12 1,819,738  3958962.69   R-squared       =    0.0362
-------------+----------------------------------   Adj R-squared   =    0.0362
       Total |  7.4749e+12 1,819,741  4107681.63   Root MSE        =    1989.7

-------------------------------------------------------------------------------
 Total_assW01 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
ex_cold_count |  -6.071568   .0875815   -69.32   0.000    -6.243224   -5.899911
 ex_hot_count |  -6.844173   .0649468  -105.38   0.000    -6.971466    -6.71688
          age |   30.13254   .1319258   228.41   0.000     29.87397    30.39111
        _cons |   1482.792   12.40056   119.57   0.000     1458.488    1507.097
-------------------------------------------------------------------------------
```

4. ***dd_ ex_ hot* & *dd_ ex_ cold* VS *dd_ hot* & *dd_ cold***

The second model better fits with the variables *dd_ ex_ hot* and *dd_ ex_ cold*.

```
. regress Total_assW01 dd_hot dd_cold

      Source |       SS           df       MS      Number of obs   = 1,832,985
-------------+----------------------------------   F(2, 1832982)   =   7518.29
       Model |  6.1237e+10         2  3.0618e+10   Prob > F        =    0.0000
    Residual |  7.4649e+12 1,832,982  4072517.68   R-squared       =    0.0081
-------------+----------------------------------   Adj R-squared   =    0.0081
       Total |  7.5261e+12 1,832,984  4105921.47   Root MSE        =      2018

------------------------------------------------------------------------------
Total_assW01 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
      dd_hot |  -1.731865   .0141835  -122.10   0.000    -1.759664   -1.704066
     dd_cold |  -.9650505   .0218092   -44.25   0.000    -1.007796   -.9223053
       _cons |   1316.067   6.576985   200.10   0.000     1303.176    1328.957
------------------------------------------------------------------------------

. regress Total_assW01 dd_ex_hot dd_ex_cold

      Source |       SS           df       MS      Number of obs   = 1,832,985
-------------+----------------------------------   F(2, 1832982)   =   7773.39
       Model |  6.3297e+10         2  3.1649e+10   Prob > F        =    0.0000
    Residual |  7.4628e+12 1,832,982  4071393.64   R-squared       =    0.0084
-------------+----------------------------------   Adj R-squared   =    0.0084
       Total |  7.5261e+12 1,832,984  4105921.47   Root MSE        =    2017.8

------------------------------------------------------------------------------
Total_assW01 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   dd_ex_hot |   -2.06183    .016646  -123.86   0.000    -2.094455   -2.029204
  dd_ex_cold |  -1.280898   .0268156   -47.77   0.000    -1.333456    -1.22834
       _cons |   1291.825   6.164969   209.54   0.000     1279.742    1303.908
------------------------------------------------------------------------------
```

Now the final choice between *ex_ hot_ count* / *ex_ cold_ count* and *dd_ ex_ hot* / *dd_ ex_ cold* must be taken, because both types of variables are the expression of the same phenomenon modeled mathematically in different way, so considering the final regression model, only one type has to be considered. Comparing the two outputs, *ex_ hot_ count* and *ex_ cold_ count* seem to better fit the model, so they are the type of variables which will be considered in the final model.

5. **Creation of the final model - Step 1**

   Considering the final regression model, the independent variables taken into account are:

   - *ex_hot_count* and *ex_cold_count*;
   - *ex_hot_year* and *ex_cold_year*, are also taken into account because Boolean modularization, which is different from the count distribution, could bring to different results not negligible in the final model;
   - *rrm*;
   - *qqm*;
   - *age*.

   We cannot consider the economic variables as *C_liab* and *NC_liab* because they are too correlated to each other. A model is reliable when the correlation between variables does not exceed the value of 0.4.

   We make a first test by inserting all the variables in the model and then we analyze the results.

   The results of the analysis are not so satisfied because of the lack of economic dependent variables. In addition to this, there are the variables *ex_hot_year* and *ex_cold_year* with a *Coef.* too high compared to all the others. We then decide to remove the two variables.

```
. regress Total_assW01 ex_cold_count ex_hot_count ex_hot_year ex_cold_year rrm qqm age
```

Source	SS	df	MS
Model	2.8813e+11	7	4.1161e+10
Residual	6.8864e+12	1,679,610	4100010.36
Total	7.1745e+12	1,679,617	4271538.33

Number of obs	= 1,679,618
F(7, 1679610)	= 10039.35
Prob > F	= 0.0000
R-squared	= 0.0402
Adj R-squared	= 0.0402
Root MSE	= 2024.8

Total_assW01	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ex_cold_count	-4.839543	.0979562	-49.41	0.000	-5.031533	-4.647552
ex_hot_count	-7.118635	.0831681	-85.59	0.000	-7.281641	-6.955628
ex_hot_year	131.215	4.60566	28.49	0.000	122.188	140.2419
ex_cold_year	85.03061	17.47579	4.87	0.000	50.77866	119.2826
rrm	.1907439	.0051861	36.78	0.000	.1805793	.2009084
qqm	-3.51373	.0535626	-65.60	0.000	-3.618711	-3.40875
age	30.00562	.1380166	217.41	0.000	29.73511	30.27612
_cons	1771.376	15.09502	117.35	0.000	1741.791	1800.962

   By eliminating the two variables *ex_hot_year* and *ex_cold_year*, in the new model *Adj R-squared* and *Root MSE* remain almost equal to those of the previous model, but now all independent variables are significant.

4.6.2 Preliminary final model

In a preliminary analysis, the linear regression model used to assess the impact of environmental events on the **total assets** variable is illustrated in Figure4.14 and Figure4.15.

Let's examine the output from this regression analysis. The *R-squared* is 0.0397, meaning that approximately 4% of the variability of *Total_ass* is accounted by the variables in the model. Let's focus on the predictors, whether they are statistically significant and, if so, the direction of the relationship:

- The coefficients of *ex_cold_count* and *ex_hot_count* are both negative, as we would have expected. An increase of one cold day in a given area in a give year causes a decrease in the value of total assets of 4.91 k€, whereas an increase of one hot day causes a decrease of 5.90 k€.

- The coefficient of *rrm* is positive. A 1 mm increase in total rainfall for a given area in a given year causes an increase in the value of total assets of 0.19 k€. Although we would have expected a negative relationship, the impact of this variable on the reliability of the model is quite modest, considering that it has the lowest beta coefficient (0.0287) and the lowest *Coef.*.

- The coefficient of *qqm* is negative, as we would expect. An increase of 1 W/m^2 of average solar radiation for a given area in a given year causes a decrease in revenues of 3.61 k€.

- The coefficient of *age* is positive, which would indicate that the maturity of a firm has a positive influence on its revenues. This may be due to the fact that a more mature company has a higher total asset value than a company that has just entered the market.

- The *_cons* is the predicted value when all the independent variables are equal to 0.

```
. regress Total_assW01 ex_cold_count ex_hot_count rrm qqm age

      Source |       SS           df       MS      Number of obs   = 1,679,618
-------------+----------------------------------   F(5, 1679612)   =  13869.85
       Model |  2.8448e+11         5  5.6897e+10   Prob > F        =    0.0000
    Residual |  6.8901e+12 1,679,612  4102176.86   R-squared       =    0.0397
-------------+----------------------------------   Adj R-squared   =    0.0396
       Total |  7.1745e+12 1,679,617  4271538.33   Root MSE        =    2025.4

------------------------------------------------------------------------------
Total_assW01 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ex_cold_count |  -4.908676   .0947076   -51.83   0.000      -5.0943   -4.723053
 ex_hot_count |  -5.903718   .0711984   -82.92   0.000    -6.043264   -5.764171
          rrm |   .1893121   .0051872    36.50   0.000     .1791453    .1994788
          qqm |  -3.607943   .0534833   -67.46   0.000    -3.712768   -3.503118
          age |   30.25604   .1377765   219.60   0.000     29.98601    30.52608
        _cons |   1680.587   14.78859   113.64   0.000     1651.602    1709.572
------------------------------------------------------------------------------
```

Figure 4.14: Linear regression model with total asset as dependent variable

```
. regress Total_assW01 ex_cold_count ex_hot_count rrm qqm age, beta

      Source |       SS           df       MS      Number of obs   = 1,679,618
-------------+----------------------------------   F(5, 1679612)   =  13869.85
       Model |  2.8448e+11         5  5.6897e+10   Prob > F        =    0.0000
    Residual |  6.8901e+12 1,679,612  4102176.86   R-squared       =    0.0397
-------------+----------------------------------   Adj R-squared   =    0.0396
       Total |  7.1745e+12 1,679,617  4271538.33   Root MSE        =    2025.4

------------------------------------------------------------------------------
Total_assW01 |      Coef.   Std. Err.      t    P>|t|                     Beta
-------------+----------------------------------------------------------------
ex_cold_count |  -4.908676   .0947076   -51.83   0.000                -.0534335
 ex_hot_count |  -5.903718   .0711984   -82.92   0.000                -.0837501
          rrm |   .1893121   .0051872    36.50   0.000                 .0286626
          qqm |  -3.607943   .0534833   -67.46   0.000                 -.053752
          age |   30.25604   .1377765   219.60   0.000                 .1673309
        _cons |   1680.587   14.78859   113.64   0.000                        .
------------------------------------------------------------------------------
```

Figure 4.15: Linear regression model with total asset as dependent variable, with st. beta coefficients

4.6.3 Regression diagnostics

Let's verify if data have met the assumptions of normality and linearity.

Normality

Let's check the normality of the residuals. As you can see from the graph below (Figure4.16), there is a massive deviation from normal.

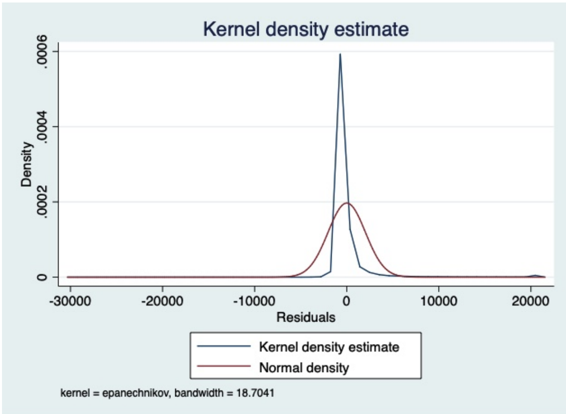

Figure 4.16: Kernel density plot for residuals with the normal option

A common cause of non-normally distributed residuals is non-normally distributed outcome and/or predictor variables. So, let us explore the distribution of our variables and how we might transform them to a more normal shape. **Logarithmic transformations** are a convenient means of transforming a highly skewed variable into one that is more approximately normal. Let's start by making histogram of the only variable not analysed in the previous paragraph (Figure4.17).

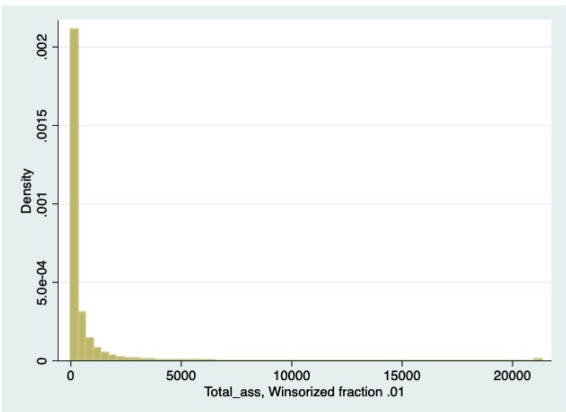

Figure 4.17: Histogram for total asset variable with normal option

In the graph above the distribution looks skewed to the right.

Let's see how the distribution of variable changes, turning it into logarithmic variable (Figure4.18).

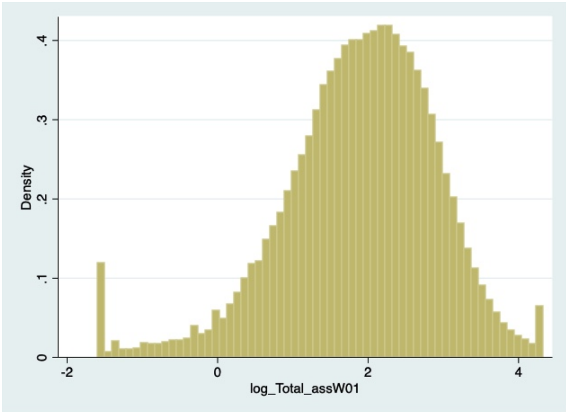

Figure 4.18: Histogram for total asset log-variable with normal option

Now the distribution looks definitely better. Also in this model, the only variable that will not be transformed into logarithm is the *age* variable, because the values of this variable are adimensional and it would make no sense to perform a logarithmic function.

Re-checking the normality of residuals in the graph below (Figure4.19), now the pattern looks better, with a small deviation from normal.

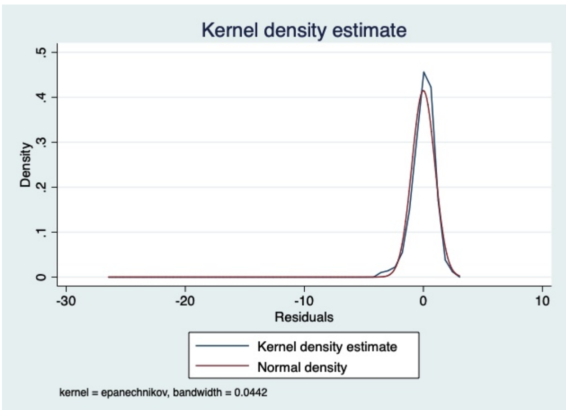

Figure 4.19: Kernel density plot for residuals with the normal option

Linearity

Linear regression needs the relationship between the independent and dependent variables to be linear. The linearity assumption can best be tested with scatter plots.

In the graphs below (Figure4.20) there isn't a clear non-linear pattern (such as a curved band or a big wave-shaped curve) so there is not the problem of non-linearity between variables.

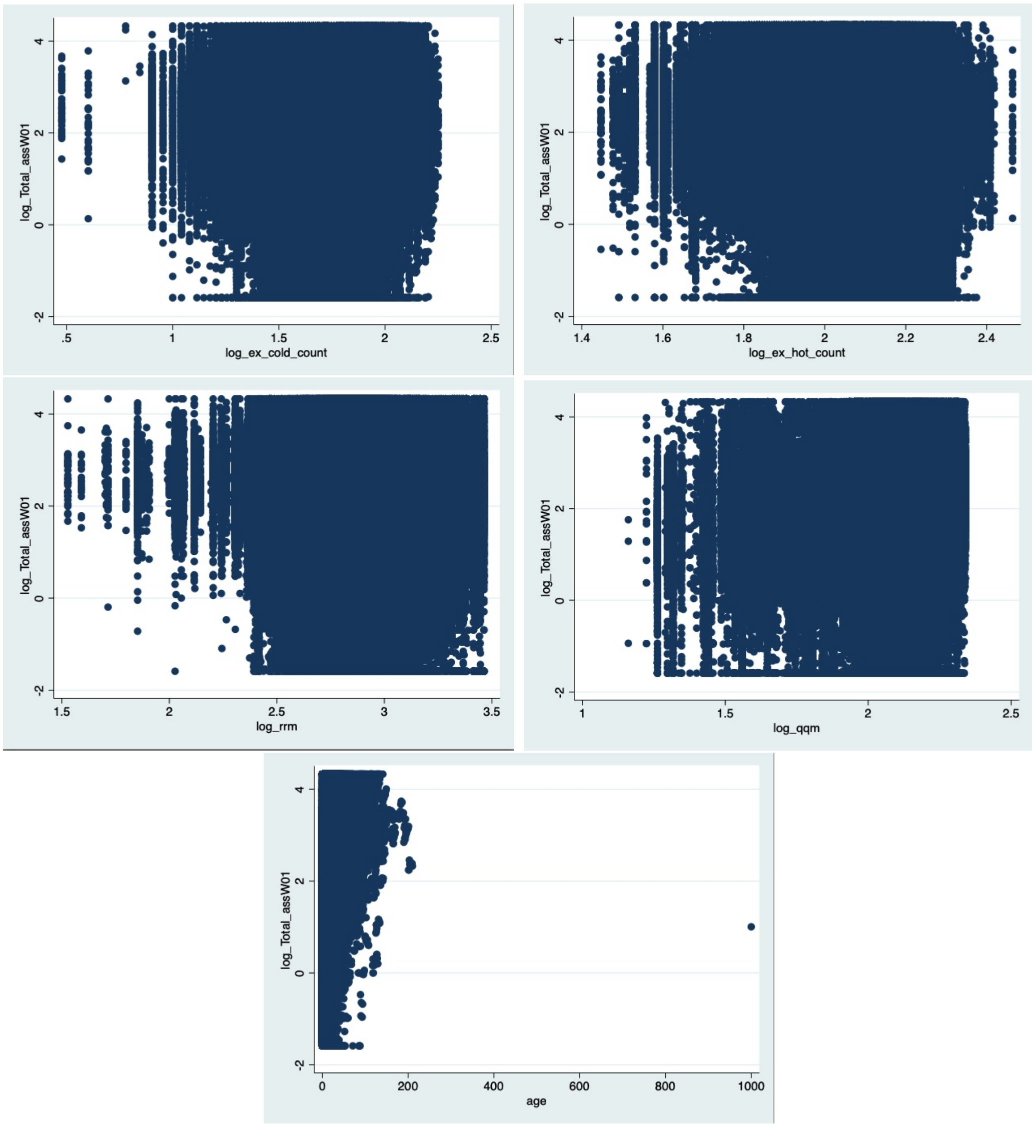

Figure 4.20: Scatter plots between the dependent variable and the predictors

Even if the scatter plots do not seem to show multi-collinearity, we need to do further checks to see if it is present or not. When there is a perfect linear relationship among the predictors, the estimates for a regression model cannot be computed. The term collinearity implies that two variables are near perfect linear combinations of one another; when more than two variables are involved it is often called multi-collinearity. Multi-collinearity may be tested with two central criteria:

- **Variance Inflation Factor (VIF)**. With VIF > 5 there is an indication that multi-collinearity may be present; with VIF > 10 there is certainly multi-collinearity among the variables. The VIFs look fine in the Figure4.21.

```
. vif
```

Variable	VIF	1/VIF
log_ex_col~t	1.79	0.557694
log_ex_hot~t	1.72	0.581320
log_qqm	1.14	0.880735
log_rrm	1.11	0.901593
age	1.02	0.982757
Mean VIF	1.36	

Figure 4.21: VIF command to check for multi-collinearity

- **Correlation matrix**. Among all independent variables the correlation coefficients need to be smaller than 1. Also the correlation coefficients look fine in the Figure4.22.

```
. correlate log_Total_assW01 log_ex_cold_count log_ex_hot_count log_rrm log_qqm age
(obs=1,679,618)
```

	log_T~01	log_ex..	log_ex..	log_rrm	log_qqm	age
log_Total~01	1.0000					
log_ex_col~t	0.0303	1.0000				
log_ex_hot~t	-0.1392	-0.6252	1.0000			
log_rrm	0.0857	0.1727	-0.2329	1.0000		
log_qqm	0.0187	0.2492	-0.0557	-0.1717	1.0000	
age	0.3084	0.0588	-0.1191	0.0679	0.0206	1.0000

Figure 4.22: Matrix indicating the correlations among all variables

4.6.4 Final model

The final linear regression model used to assess the impact of environmental events on the **total assets** variable is illustrated in Figure4.23 and Figure4.24.

Let's examine the output from this regression analysis. The *R-squared* is 0.1136, significantly higher than the model of the preliminary analysis, where approximately 4% of the variability of *Total_ass* is accounted by the variables in the model. *Root MSE* has decreased significantly due to much smaller coefficients. Let's focus on the predictors, whether they are statistically significant and, if so, the direction of the relationship.

- The coefficients of *log_ex_cold_count* and *log_ex_hot_count* are both negative, as we would have expected. An increase of 1% in ex_cold_count causes a decrease in total assets of 0.67%[10], whereas an increase of 1% in ex_hot_count causes a decrease of 1.35%[11]. It can be seen that the impact of the variable related to abnormal hot temperatures on total assets is greater than that on revenues.
- The coefficients of *log_rrm* and *log_qqm* are positive, contrary to our expectations. A 1% increase in the total rainfall for a given area in a given year causes an increase in total assets of 0.35%[12] and an increase of 1% in the average solar radiation for a given area in a given year causes an increase of 0.15%[13]. Contrary to the preliminary final model, where *rrm* was quite insignificant, now the impact of these new variables on the reliability of the model is almost equal (0.0545 and 0.0389).
- The coefficient of *age* is positive, which would indicate that the maturity of a firm has a positive influence on its total assets; a company one year older increases the value of the total assets by 6.18%[14].
- The *_cons* is the predicted value when all the independent variables are equal to 0. Usually, the constant is not very interesting.

[10]the result comes out by this calculation: $(1 - 10^{log(1.01)*-0.6714285}) * 100$
[11]the result comes out by this calculation: $(1 - 10^{log(1.01)*-1.362502}) * 100$
[12]the result comes out by this calculation: $(10^{log(1.01)*0.3469828} - 1) * 100$
[13]the result comes out by this calculation: $(10^{log(1.01)*0.3574662} - 1) * 100$
[14]the result comes out by this calculation: $(10^{0.0230524} - 1) * 100$

```
. regress log_Total_assW01 log_ex_cold_count log_ex_hot_count log_rrm log_qqm age

      Source |       SS           df       MS      Number of obs   = 1,679,618
-------------+----------------------------------   F(5, 1679612)   =  43039.01
       Model |  198911.865         5   39782.373   Prob > F        =    0.0000
    Residual |  1552520.69 1,679,612  .924332937   R-squared       =    0.1136
-------------+----------------------------------   Adj R-squared   =    0.1136
       Total |  1751432.56 1,679,617   1.0427571   Root MSE        =    .96142

------------------------------------------------------------------------------------
 log_Total_assW01 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
------------------+-----------------------------------------------------------------
log_ex_cold_count |  -.6714285   .0064183  -104.61   0.000    -.6840081   -.6588488
 log_ex_hot_count |  -1.362502   .0084744  -160.78   0.000    -1.379111   -1.345892
          log_rrm |   .3469828   .0048697    71.25   0.000     .3374384    .3565272
          log_qqm |   .3574662    .007116    50.23   0.000      .343519    .3714134
              age |   .0260524   .0000655   397.94   0.000      .025924    .0261807
            _cons |   3.875386   .0327007   118.51   0.000     3.811294    3.939479
------------------------------------------------------------------------------------
```

Figure 4.23: Linear regression model with total asset as dependent variable

```
. regress log_Total_assW01 log_ex_cold_count log_ex_hot_count log_rrm log_qqm age, beta

      Source |       SS           df       MS      Number of obs   = 1,679,618
-------------+----------------------------------   F(5, 1679612)   =  43039.01
       Model |  198911.865         5   39782.373   Prob > F        =    0.0000
    Residual |  1552520.69 1,679,612  .924332937   R-squared       =    0.1136
-------------+----------------------------------   Adj R-squared   =    0.1136
       Total |  1751432.56 1,679,617   1.0427571   Root MSE        =    .96142

------------------------------------------------------------------------------------
 log_Total_assW01 |      Coef.   Std. Err.      t    P>|t|                     Beta
------------------+-----------------------------------------------------------------
log_ex_cold_count |  -.6714285   .0064183  -104.61   0.000                 -.1017649
 log_ex_hot_count |  -1.362502   .0084744  -160.78   0.000                 -.1531924
          log_rrm |   .3469828   .0048697    71.25   0.000                  .0545156
          log_qqm |   .3574662    .007116    50.23   0.000                  .0388858
              age |   .0260524   .0000655   397.94   0.000                  .2916162
            _cons |   3.875386   .0327007   118.51   0.000                         .
------------------------------------------------------------------------------------
```

Figure 4.24: Linear regression model with total asset as dependent variable, with st. beta coefficients

4.7 Current and non-current liabilities indicators

In this case the two regression models with independent variables current liabilities and non-current liabilities are analysed in parallel.

4.7.1 Models construction

Regarding the choice of environmental variables to adopt in the model, we will repeat the trial and error approach used in the previous model. The observations we will conduct for the dependent variable *C_ liab* are also valid for *NC_ liab*.

1. ***cold_ count* & *hot_ count* VS *cold_ mean* & *hot_ mean***

   The comparison of these two outputs shows that *cold_ mean* and *hot_ mean* better fit the model. In fact, using the *Adj R-squared* as discriminating, the first output has a value higher than the one of the second model. Consequently, *cold_ count* and *hot_ count* would not be considered in further regression models with total asset as dependent variable.

```
. regress C_liabW01 cold_count hot_count

      Source |       SS           df       MS      Number of obs   = 1,826,862
-------------+----------------------------------   F(2, 1826859)   =   5297.23
       Model |  5.6052e+09         2  2.8026e+09   Prob > F        =    0.0000
    Residual |  9.6653e+11 1,826,859  529067.077   R-squared       =    0.0058
-------------+----------------------------------   Adj R-squared   =    0.0058
       Total |  9.7214e+11 1,826,861  532134.699   Root MSE        =    727.37

------------------------------------------------------------------------------
   C_liabW01 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  cold_count |  -1.966263   .0331007   -59.40   0.000    -2.031139   -1.901387
   hot_count |  -2.633929   .0263863   -99.82   0.000    -2.685645   -2.582213
       _cons |   756.0183    5.88842   128.39   0.000     744.4772    767.5594
------------------------------------------------------------------------------
```

```
. regress C_liabW01 cold_mean hot_mean

      Source |       SS           df       MS      Number of obs   = 1,826,862
-------------+----------------------------------   F(2, 1826859)   =   8935.44
       Model |  9.4176e+09         2  4.7088e+09   Prob > F        =    0.0000
    Residual |  9.6272e+11 1,826,859  526980.205   R-squared       =    0.0097
-------------+----------------------------------   Adj R-squared   =    0.0097
       Total |  9.7214e+11 1,826,861  532134.699   Root MSE        =    725.93

------------------------------------------------------------------------------
   C_liabW01 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   cold_mean |   79.12375   .9789602    80.82   0.000     77.20502    81.04248
    hot_mean |  -90.86204   1.337298   -67.94   0.000    -93.48309   -88.24098
       _cons |   601.5513   2.951771   203.79   0.000     595.7659    607.3367
------------------------------------------------------------------------------
```

2. ***ex_ cold_ count*** & ***ex_ hot_ count*** VS ***ex_ cold_ mean*** & ***ex_ hot_ mean***

The comparison of the two outputs confirmed that the variables that represent the mean dense in the model better than its count.

```
. regress C_liabW01 ex_cold_count ex_hot_count

      Source |       SS           df       MS      Number of obs   = 1,826,862
-------------+----------------------------------   F(2, 1826859)   =   5403.03
       Model |  5.7165e+09         2  2.8582e+09   Prob > F        =    0.0000
    Residual |  9.6642e+11 1,826,859  529006.156   R-squared       =    0.0059
-------------+----------------------------------   Adj R-squared   =    0.0059
       Total |  9.7214e+11 1,826,861  532134.699   Root MSE        =    727.33

------------------------------------------------------------------------------
   C_liabW01 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ex_cold_count |  -1.932243   .0319849   -60.41   0.000    -1.994933   -1.869554
 ex_hot_count |   -2.44153   .0236396  -103.28   0.000    -2.487863   -2.395198
        _cons |   651.0463   4.465304   145.80   0.000     642.2945    659.7981
------------------------------------------------------------------------------

. regress C_liabW01 ex_cold_mean ex_hot_mean

      Source |       SS           df       MS      Number of obs   = 1,826,862
-------------+----------------------------------   F(2, 1826859)   =   7982.53
       Model |  8.4220e+09         2  4.2110e+09   Prob > F        =    0.0000
    Residual |  9.6371e+11 1,826,859  527525.201   R-squared       =    0.0087
-------------+----------------------------------   Adj R-squared   =    0.0087
       Total |  9.7214e+11 1,826,861  532134.699   Root MSE        =    726.31

------------------------------------------------------------------------------
   C_liabW01 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ex_cold_mean |   77.83896   .9715752    80.12   0.000      75.9347    79.74321
 ex_hot_mean |  -95.01737   1.416172   -67.09   0.000    -97.79302   -92.24172
       _cons |    581.279   2.982473   194.90   0.000     575.4334    587.1245
------------------------------------------------------------------------------
```

Now, given the similar nature of count variables, the presence of one type in the final regression model excludes the other. To determine which of the two continue to take into account another comparison between the two was made but including the variables *age*.

3. ***cold_ mean* & *hot_ mean* VS *ex_ cold_ mean* & *ex_ hot_ mean***

Comparing the indicators, *cold_ mean* and *hot_ mean* better fit.

```
. regress C_liabW01 cold_mean hot_mean age

      Source |       SS           df       MS      Number of obs   = 1,813,658
-------------+----------------------------------   F(3, 1813654)   =  17456.91
       Model |  2.7126e+10         3  9.0421e+09   Prob > F        =    0.0000
    Residual |  9.3941e+11 1,813,654  517967.663   R-squared       =    0.0281
-------------+----------------------------------   Adj R-squared   =    0.0281
       Total |  9.6654e+11 1,813,657  532923.519   Root MSE        =     719.7

------------------------------------------------------------------------------
   C_liabW01 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   cold_mean |   69.43916   .9746293    71.25   0.000     67.52892     71.3494
    hot_mean |  -73.21521   1.332106   -54.96   0.000    -75.82609   -70.60433
         age |    8.83267   .0477301   185.05   0.000      8.73912    8.926219
       _cons |   445.2251   3.050492   145.95   0.000     439.2462    451.2039
------------------------------------------------------------------------------

. regress C_liabW01 ex_cold_mean ex_hot_mean age

      Source |       SS           df       MS      Number of obs   = 1,813,658
-------------+----------------------------------   F(3, 1813654)   =  16986.99
       Model |  2.6416e+10         3  8.8054e+09   Prob > F        =    0.0000
    Residual |  9.4012e+11 1,813,654  518359.275   R-squared       =    0.0273
-------------+----------------------------------   Adj R-squared   =    0.0273
       Total |  9.6654e+11 1,813,657  532923.519   Root MSE        =    719.97

------------------------------------------------------------------------------
   C_liabW01 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ex_cold_mean |   68.24346   .9670828    70.57   0.000     66.34801    70.13891
 ex_hot_mean |  -76.38713   1.411055   -54.13   0.000    -79.15275   -73.62151
         age |   8.898308   .0477159   186.49   0.000     8.804787     8.99183
       _cons |   426.6051   3.076262   138.68   0.000     420.5758    432.6345
------------------------------------------------------------------------------
```

4. ***dd_ ex_ hot* & *dd_ ex_ cold* VS *dd_ hot* & *dd_ cold***

The first model better fits with the variables *dd_ hot* and *dd_ cold*.

```
. regress C_liabW01 dd_cold dd_hot

      Source |       SS           df       MS      Number of obs   = 1,826,862
-------------+----------------------------------   F(2, 1826859)   =   9366.63
       Model |  9.8674e+09         2  4.9337e+09   Prob > F        =    0.0000
    Residual |  9.6227e+11 1,826,859  526733.967   R-squared       =    0.0102
-------------+----------------------------------   Adj R-squared   =    0.0101
       Total |  9.7214e+11 1,826,861  532134.699   Root MSE        =    725.76

------------------------------------------------------------------------------
   C_liabW01 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     dd_cold |  -.5619604   .0078544   -71.55   0.000    -.5773548   -.5465661
      dd_hot |  -.6742919   .0051158  -131.80   0.000    -.6843188    -.664265
       _cons |   539.9867   2.369701   227.87   0.000     535.3422    544.6312
------------------------------------------------------------------------------
```

```
. regress C_liabW01 dd_ex_cold dd_ex_hot

      Source |       SS           df       MS      Number of obs   = 1,826,862
-------------+----------------------------------   F(2, 1826859)   =   8869.63
       Model |  9.3489e+09         2  4.6745e+09   Prob > F        =    0.0000
    Residual |  9.6279e+11 1,826,859  527017.804   R-squared       =    0.0096
-------------+----------------------------------   Adj R-squared   =    0.0096
       Total |  9.7214e+11 1,826,861  532134.699   Root MSE        =    725.96

------------------------------------------------------------------------------
   C_liabW01 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  dd_ex_cold |  -.6892279   .0096624   -71.33   0.000     -.708166   -.6702899
   dd_ex_hot |  -.7673751   .0060071  -127.74   0.000    -.7791488   -.7556014
       _cons |   514.3679   2.222394   231.45   0.000     510.0121    518.7237
------------------------------------------------------------------------------
```

Now the final choice between *cold_ mean* / *hot_ mean* and *dd_ hot* / *dd_ cold* must be taken, because both types of variables are the expression of the same phenomenon modeled mathematically in different way, so considering the final regression model, only one type has to be considered. Comparing the two outputs, using also the independent variables *age*, *rrm*, *qqm*, *cold_ mean* and *hot_ mean* seem to better fit the model, so they are the type of variables which will be considered in the final model.

5. **Creation of the final model - Step 1**

Considering the study made on variables in the models with revenue and total asset as dependent variables, we decide to use the logarithmic variables directly. The independent variables taken into account in the model for the preliminary analysis are:

- *cold_mean* and *hot_mean*, not transformed into logarithmic variables since they correspond to an average that, as in the case of *cold_mean*, is negative and therefore impossible to transform into logarithm;
- *cold_year* and *hot_year*, not transformed into logarithmic variables because they are Boolean variables. They are also taken into account because Boolean modularization, which is different from the count distribution, could bring to different results not negligible in the final model;
- *log_rrm*;
- *log_qqm*;
- *age*, not transformed into logarithmic variable as in the previous models.

We make a first test by inserting all the variables in the model and then we analyze the results.

```
. regress log_C_liabW01 cold_mean hot_mean cold_year hot_year log_rrm log_qqm age
```

Source	SS	df	MS		
Model	106065.374	7	15152.1962	Number of obs	= 1,557,473
Residual	1517644.34	1,557,465	.974432392	F(7, 1557465)	= 15549.77
				Prob > F	= 0.0000
Total	1623709.72	1,557,472	1.04252899	R-squared	= 0.0653
				Adj R-squared	= 0.0653
				Root MSE	= .98713

log_C_lia~01	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
cold_mean	.1345227	.0016296	82.55	0.000	.1313287	.1377168
hot_mean	-.2235636	.0022089	-101.21	0.000	-.227893	-.2192341
cold_year	.0318284	.0050431	6.31	0.000	.021944	.0417128
hot_year	-.0368224	.0018269	-20.16	0.000	-.040403	-.0332418
log_rrm	-.0388286	.0051645	-7.52	0.000	-.0489508	-.0287065
log_qqm	-.6288938	.0076029	-82.72	0.000	-.6437951	-.6139924
age	.0179815	.0000722	248.98	0.000	.01784	.0181231
_cons	3.575657	.0262036	136.46	0.000	3.524299	3.627015

By eliminating the two variables *ex_hot_year* and *ex_cold_year*, in the new model *Adj R-squared* and *Root MSE* remain almost equal to those of the previous model as they add nothing to the model that is not already explained by *cold_mean* and *hot_mean*.

4.7.2 Preliminary final models

In a preliminary analysis, the linear regression models used to assess the impact of environmental events on the **current liabilities** and **non-current liabilities** variables are illustrated in Figure4.25 and Figure4.26.

Let's compare the outputs from these regression analysis. The *R-squared* is a low value in both models: in the first model approximately 6.5% of the variability of *log_C_liab* is accounted by the variables in the model, while in the second only 5.5%. First we will check if data meet the assumptions and then we will comment the outputs.

```
. regress log_C_liabW01 cold_mean hot_mean log_rrm log_qqm age, beta

      Source |       SS           df       MS      Number of obs   = 1,557,473
-------------+----------------------------------   F(5, 1557467)   =  21673.40
       Model |  105626.699         5  21125.3397   Prob > F        =    0.0000
    Residual |  1518083.02 1,557,467    .9747128   R-squared       =    0.0651
-------------+----------------------------------   Adj R-squared   =    0.0650
       Total |  1623709.72 1,557,472  1.04252899   Root MSE        =    .98728

------------------------------------------------------------------------------
log_C_lia~01 |      Coef.   Std. Err.      t    P>|t|                     Beta
-------------+----------------------------------------------------------------
   cold_mean |   .1206418   .0014854    81.22   0.000                  .069797
    hot_mean |  -.2437695   .0019887  -122.58   0.000                -.1049844
     log_rrm |  -.0220342   .0051042    -4.32   0.000                -.0034907
     log_qqm |  -.6157647   .0075787   -81.25   0.000                -.0674675
         age |   .0180526   .0000721   250.29   0.000                 .1956147
       _cons |   3.501251   .0259703   134.82   0.000                        .
------------------------------------------------------------------------------
```

Figure 4.25: Linear regression model with current liabilities as dependent variable, with st. beta coefficients

```
. regress log_NC_liabW01 cold_mean hot_mean log_rrm log_qqm age, beta

      Source |       SS           df       MS      Number of obs   =   896,222
-------------+----------------------------------   F(5, 896216)    =  10467.88
       Model |  42630.7028         5  8526.14055   Prob > F        =    0.0000
    Residual |  729972.166   896,216  .814504725   R-squared       =    0.0552
-------------+----------------------------------   Adj R-squared   =    0.0552
       Total |  772602.869   896,221  .862067357   Root MSE        =     .9025

------------------------------------------------------------------------------
log_NC_li~01 |      Coef.   Std. Err.      t    P>|t|                     Beta
-------------+----------------------------------------------------------------
   cold_mean |   .0066772   .0017789     3.75   0.000                 .0042396
    hot_mean |  -.0462713   .0024258   -19.07   0.000                -.0215486
     log_rrm |   .0871994    .006099    14.30   0.000                 .0153615
     log_qqm |  -.6910312   .0097282   -71.03   0.000                -.0796977
         age |   .0161728   .0000768   210.68   0.000                 .2171512
       _cons |   2.766123   .0327363    84.50   0.000                        .
------------------------------------------------------------------------------
```

Figure 4.26: Linear regression model with non-current liabilities as dependent variable, with st. beta coefficients

4.7.3 Regression diagnostics

Let's verify if data have met the assumptions of normality and linearity.

Normality

Let's check the normality of the residuals. As you can see from the graphs below (Figure4.27 and Figure4.28), in both graphs there is a deviation from normal which is acceptable.

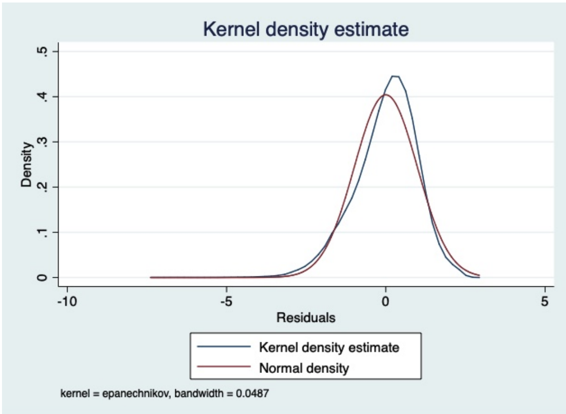

Figure 4.27: Kernel density plot for residuals with the normal option with current liabilities as dependent variable

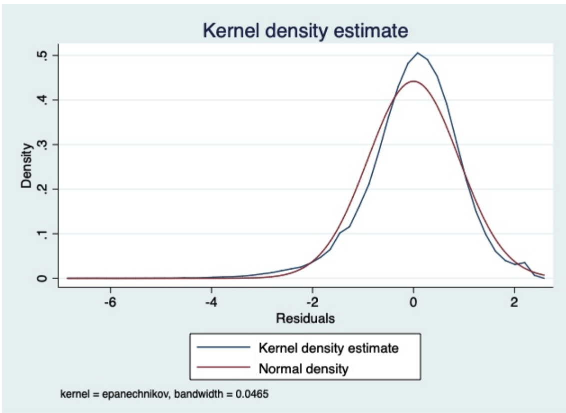

Figure 4.28: Kernel density plot for residuals with the normal option with non-current liabilities as dependent variable

We plot the histograms of variables *cold_ mean* and *hot_ mean* (Figure4.29) to see if the distribution is particularly skewed or not.

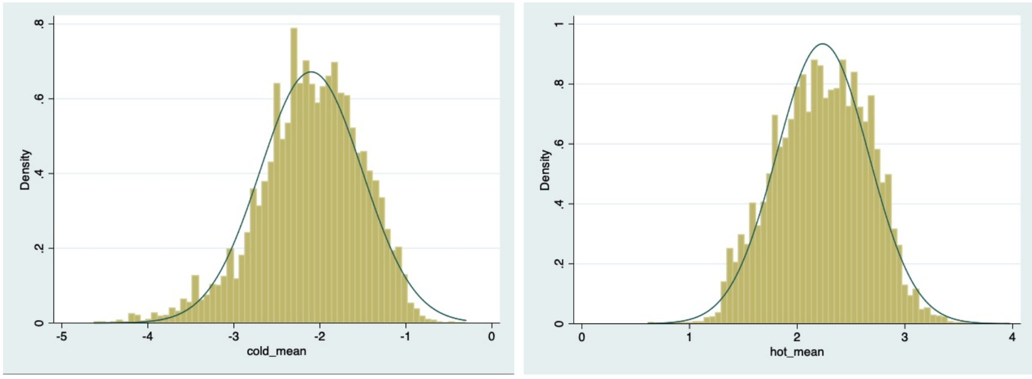

Figure 4.29: Histogram for all the variables not-analysed in the model with normal option

In all of the graphs above the distribution doesn't look skewed. For this reason, we consider the normality hypothesis verified.

Linearity

Linear regression needs the relationship between the independent and dependent variables to be linear. The linearity assumption can best be tested with scatter plots.

In all the relationships analysed between dependent and independent variables there isn't a clear non-linear pattern (such as a curved band or a big wave-shaped curve) so there is not the problem of non-linearity between variables. We avoid to display all the scatter plots.

Even if the scatter plots do not seem to show multi-collinearity, we need to do further checks to see if it is present or not. When there is a perfect linear relationship among the predictors, the estimates for a regression model cannot be computed. The term collinearity implies that two variables are near perfect linear combinations of one another; when more than two variables are involved it is often called multi-collinearity. Multi-collinearity may be tested with two central criteria:

- **Variance Inflation Factor (VIF)**. With VIF > 5 there is an indication that multi-collinearity may be present; with VIF > 10 there is certainly multi-collinearity among the variables. The VIFs look fine in the Figure4.30 and Figure4.31.

```
. vif
```

Variable	VIF	1/VIF
cold_mean	1.23	0.812866
hot_mean	1.22	0.818333
log_qqm	1.15	0.870603
log_rrm	1.09	0.918086
age	1.02	0.982749
Mean VIF	1.14	

Figure 4.30: VIF command to check for multi-collinearity with current liabilities as dependent variable

```
. vif
```

Variable	VIF	1/VIF
hot_mean	1.21	0.826058
cold_mean	1.21	0.826405
log_qqm	1.19	0.837484
log_rrm	1.10	0.913231
age	1.01	0.992364
Mean VIF	1.14	

Figure 4.31: VIF command to check for multi-collinearity with non-current liabilities as dependent variable

- **Correlation matrix**. Among all independent variables the correlation coefficients need to be smaller than 1. Also the correlation coefficients look fine in the Figure4.32 and Figure4.33.

```
. correlate log_C_liabW01 cold_mean hot_mean log_rrm log_qqm age
(obs=1,557,473)
```

	log_C_~1	cold_m~n	hot_mean	log_rrm	log_qqm	age
log_C_lia~01	1.0000					
cold_mean	0.1087	1.0000				
hot_mean	-0.1395	-0.3775	1.0000			
log_rrm	0.0450	0.1098	-0.1606	1.0000		
log_qqm	-0.0226	0.2592	-0.2044	-0.1749	1.0000	
age	0.2119	0.0874	-0.1151	0.0622	0.0243	1.0000

Figure 4.32: Matrix indicating the correlations among all variables with current liabilities as dependent variable

```
. correlate log_NC_liabW01 cold_mean hot_mean log_rrm log_qqm age
(obs=896,222)
```

	log_N~01	cold_m~n	hot_mean	log_rrm	log_qqm	age
log_NC_li~01	1.0000					
cold_mean	0.0036	1.0000				
hot_mean	-0.0181	-0.3560	1.0000			
log_rrm	0.0468	0.0815	-0.1377	1.0000		
log_qqm	-0.0782	0.2780	-0.2471	-0.2008	1.0000	
age	0.2202	0.0579	-0.0581	0.0558	-0.0089	1.0000

Figure 4.33: Matrix indicating the correlations among all variables with non-current liabilities as dependent variable

4.7.4 Final models

The final linear regression models used to assess the impact of environmental events on the **current liabilities** and **non-current liabilities** variables are the same of the preliminary analysis, illustrated in Figure4.34 and Figure4.35.

Let's examine the output from this regression analysis. The *R-squared* are quite different in the two model: 0.0651 in the one with current liability as dependent variable and 0.0552 in the other.

- The coefficient of *cold_mean* is positive in both models. A unit decrease in cold_mean (and not increase since it is a negative variable) causes a decrease in current liabilities of 32.02%[15],and a decrease in non-current liabilities of 1.55%[16]. These results have more impact than the values highlighted in previous models, quantitatively speaking, because in this case we are talking about average and not counting the days with abnormal temperatures. It is difficult, however, states that abnormal cold temperatures have a positive impact on long-term and short-term corporate debt, as apparently it might seem. An increasing trend can indicate that a business is unwilling or unable to pay down its debt, which could indicate a default in the future; at the same time greater exposure to debt means that the company is able to grow and thus increase its revenues in the short term. Therefore, debt reduction, i.e. the loss of the capacity to get into debt, cannot be considered an always positive event.
- The coefficient of *hot_mean* is negative in both models. A unit increase in hot_mean causes a decrease in current liabilities of 42.95%[17], and a decrease in non-current liabilities of 10.11%[18]. The attitude of this variable is the same as *cold_mean*, so we can confirm the same considerations made previously.
- The coefficient of *log_rrm* is negative in the first model (with current liabilities as dependent variable) and positive in the other. A 1% increase in the total rainfall for a given area in a given year causes a decrease in current liabilities of 0.02%[19] and a increase in non-current liabilities of 0.09%[20]. The effect of this variable on both short and long term debt is minimal.
- The coefficient of *log_qqm* is negative in both models. An increase of 1% in the average solar radiation for a given area in a given year causes a decrease of 0.61%[21] and a decrease in non-current liabilities of 0.68%[22]. The effect is slightly more amplified for long-term debt than short-term debt. Here too, a reduction in debt cannot necessarily be considered a positive effect, as described above.

[15]the result comes out by this calculation: $(10^{0.1206418} - 1) * 100$
[16]the result comes out by this calculation: $(10^{0.0066772} - 1) * 100$
[17]the result comes out by this calculation: $(1 - 10^{-0.2437695}) * 100$
[18]the result comes out by this calculation: $(1 - 10^{-0.0462713}) * 100$
[19]the result comes out by this calculation: $(1 - 10^{log(1.01)*-0.1167538}) * 100$
[20]the result comes out by this calculation: $(10^{log(1.01)*0.0871994} - 1) * 100$
[21]the result comes out by this calculation: $(1 - 10^{log(1.01)*-0.6157647}) * 100$
[22]the result comes out by this calculation: $(1 - 10^{log(1.01)*-0.6910312}) * 100$

- The coefficient of *age* is positive in both models. A company one year older increases the value of the current liabilities by 4.24%[23] and the value of the non-current liabilities by 3.79%[24]. This suggests that the growth of a company over the years is correlated with the increase in debt.

- The _ *cons* is the predicted value when all the independent variables are equal to 0. Usually, the constant is not very interesting.

[23]the result comes out by this calculation: $(10^{0.0180526} - 1) * 100$

[24]the result comes out by this calculation: $(10^{0.0161728} - 1) * 100$

```
. regress log_C_liabW01 cold_mean hot_mean log_rrm log_qqm age, beta

      Source |       SS           df       MS      Number of obs   = 1,557,473
-------------+----------------------------------   F(5, 1557467)   =  21673.40
       Model |  105626.699         5  21125.3397   Prob > F        =    0.0000
    Residual |  1518083.02 1,557,467    .9747128   R-squared       =    0.0651
-------------+----------------------------------   Adj R-squared   =    0.0650
       Total |  1623709.72 1,557,472  1.04252899   Root MSE        =    .98728

------------------------------------------------------------------------------
log_C_lia~01 |      Coef.   Std. Err.      t    P>|t|                     Beta
-------------+----------------------------------------------------------------
   cold_mean |   .1206418   .0014854    81.22   0.000                  .069797
    hot_mean |  -.2437695   .0019887  -122.58   0.000                -.1049844
     log_rrm |  -.0220342   .0051042    -4.32   0.000                -.0034907
     log_qqm |  -.6157647   .0075787   -81.25   0.000                -.0674675
         age |   .0180526   .0000721   250.29   0.000                 .1956147
       _cons |   3.501251   .0259703   134.82   0.000                        .
------------------------------------------------------------------------------
```

Figure 4.34: Linear regression model with current liabilities as dependent variable, with st. beta coefficients

```
. regress log_NC_liabW01 cold_mean hot_mean log_rrm log_qqm age, beta

      Source |       SS           df       MS      Number of obs   =   896,222
-------------+----------------------------------   F(5, 896216)    =  10467.88
       Model |  42630.7028         5  8526.14055   Prob > F        =    0.0000
    Residual |  729972.166   896,216  .814504725   R-squared       =    0.0552
-------------+----------------------------------   Adj R-squared   =    0.0552
       Total |  772602.869   896,221  .862067357   Root MSE        =     .9025

------------------------------------------------------------------------------
log_NC_li~01 |      Coef.   Std. Err.      t    P>|t|                     Beta
-------------+----------------------------------------------------------------
   cold_mean |   .0066772   .0017789     3.75   0.000                 .0042396
    hot_mean |  -.0462713   .0024258   -19.07   0.000                -.0215486
     log_rrm |   .0871994    .006099    14.30   0.000                 .0153615
     log_qqm |  -.6910312   .0097282   -71.03   0.000                -.0796977
         age |   .0161728   .0000768   210.68   0.000                 .2171512
       _cons |   2.766123   .0327363    84.50   0.000                        .
------------------------------------------------------------------------------
```

Figure 4.35: Linear regression model with non-current liabilities as dependent variable, with st. beta coefficients

4.8 Debt ratio indicator

Following the analysis carried out with operating revenues and total assets as dependent variables, it would have been appropriate to carry out a further analysis with the ROA indicator but the results were quite unreliable (with an *R-squared* equal to 0.0000). This is due to variable *Cost_sold*, used for the calculation of the ROA, which with a number of observations that is much lower than the other variables, leads to a *Number of obs* for the construction of the model equal to 88,461 , about 18 times less than the following model, with a number of observations equivalent to 1,600,125.

After analysing the dependent variables referring to total assets and current / non-current liabilities, we will now define and subsequently analyse the financial indicator **debt ratio** that includes these variables. It defines the total amount of debt relative to assets owned by a company. This will help assess whether the company's financial risk profile is improving or deteriorating. The indicator is defined as follows:

$$Debt\_ratio = \frac{C\_liabW01 + NC\_liabW01}{Total\_assW01} = \frac{Total\_liabW01}{Total\_assW01} \tag{4.1}$$

We avoid to explain the steps for the creation of the preliminary model and the check if the data have meet the assumption of linearity and normality, but we directly illustrate the final model (in Figure4.36 and Figure4.37).

Let's examine the output, comparing it to the models with total assets, current and non-current liabilities variables. The *R-squared* is 0.015 and is the lowest of all defined models.

- The coefficients of *log_ex_cold_count* and *log_ex_hot_count* are both positive. An increase of 1% in *ex_cold_count* causes an increase in the debt ratio of 0.04%[25] and an increase of 1% in *ex_hot_count* causes an increase of 0.23%[26]. An abnormal increase in hot temperatures and an abnormal decrease in cold temperatures, in a given area and in a given year, causes a decrease in the value of total assets and at the same time total liabilities. Further analysis of this model has shown that an increase and decrease in hot and cold temperatures respectively causes an increase in the ratio of total liabilities to total assets. This means that the degrowth rate of total assets is higher than that of total liabilities. Therefore, the total value of assets decreases more quickly than the decrease in liabilities. All this is to be considered in a negative way, as this means that the decrease in debt is not due to debt restructuring or better debt management but is due to a lack of corporate growth.

[25] the result comes out by this calculation: $(10^{log(1.01)*0.0382657} - 1) * 100$

[26] the result comes out by this calculation: $(10^{log(1.01)*0.2286745} - 1) * 100$

- The coefficients of *log_ rrm* and *log_ qqm* are both negative. A 1% increase in the total rainfall for a given area in a given year causes a decrease in the debt ratio of 0.16%[27] and a 1% increase in the average solar radiation for a given area in a given year causes a decrease in the debt ratio of 0.24%[28]. An increase in the average solar radiations causes an increase in the value of total assets and a decrease in total liabilities, as confirmed by the decrease in the *debt_ ratio*; this means that this climate factor does not have such a negative impact on company performance. The same applies to the variable *rrm*, where an increase in the total rainfall causes an increase in the value of total assets and an increase in the value of non-current liabilities, but considering that the influence of this climate variable on the debt ratio is negative, the growth rate of assets is higher than the growth rate of non-current liabilities.

[27] the result comes out by this calculation: $(1 - 10^{log(1.01)*-0.1606387}) * 100$

[28] the result comes out by this calculation: $(1 - 10^{log(1.01)*-0.241789}) * 100$

```
. regress log_debt_ratio log_ex_cold_count log_ex_hot_count log_rrm log_qqm age

      Source |       SS           df       MS      Number of obs   = 1,600,125
-------------+----------------------------------   F(5, 1600119)   =   4871.95
       Model |  8659.83996         5  1731.96799   Prob > F        =    0.0000
    Residual |  568838.464 1,600,119    .3554976   R-squared       =    0.0150
-------------+----------------------------------   Adj R-squared   =    0.0150
       Total |  577498.304 1,600,124  .360908469   Root MSE        =    .59624

------------------------------------------------------------------------------
log_debt_ratio |     Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
---------------+--------------------------------------------------------------
log_ex_cold_count |  .0382657   .0040987     9.34   0.000     .0302325     .046299
 log_ex_hot_count |  .2286745   .0054125    42.25   0.000     .2180662    .2392828
          log_rrm | -.1606387   .0030772   -52.20   0.000    -.1666698   -.1546075
          log_qqm |  -.241789   .0045264   -53.42   0.000    -.2506607   -.2329174
              age | -.0047185   .0000416  -113.47   0.000       -.0048    -.004637
            _cons |  .2646098   .0209264    12.64   0.000     .2235948    .3056247
------------------------------------------------------------------------------
```

Figure 4.36: Linear regression model with debt ratio as dependent variable

```
. regress log_debt_ratio log_ex_cold_count log_ex_hot_count log_rrm log_qqm age, beta

      Source |       SS           df       MS      Number of obs   = 1,600,125
-------------+----------------------------------   F(5, 1600119)   =   4871.95
       Model |  8659.83996         5  1731.96799   Prob > F        =    0.0000
    Residual |  568838.464 1,600,119    .3554976   R-squared       =    0.0150
-------------+----------------------------------   Adj R-squared   =    0.0150
       Total |  577498.304 1,600,124  .360908469   Root MSE        =    .59624

------------------------------------------------------------------------------
log_debt_ratio |     Coef.   Std. Err.      t    P>|t|                    Beta
---------------+--------------------------------------------------------------
log_ex_cold_count |  .0382657   .0040987     9.34   0.000                .0098583
 log_ex_hot_count |  .2286745   .0054125    42.25   0.000                 .043768
          log_rrm | -.1606387   .0030772   -52.20   0.000               -.0431773
          log_qqm |  -.241789   .0045264   -53.42   0.000               -.0446193
              age | -.0047185   .0000416  -113.47   0.000               -.0898348
            _cons |  .2646098   .0209264    12.64   0.000                       .
------------------------------------------------------------------------------
```

Figure 4.37: Linear regression model with debt ratio as dependent variable, with st. beta coefficients

4.9 Conclusions

The results obtained from regression models suggest that environmental variables have a non-negligible impact on company performances. Below we reported the final results of the analysis of the regression models; they have been deduced considering the averages values of operating revenues, total assets, current liabilities and non-current liabilities variables for the year 2018, belonging to 308,356 small and medium enterprises' results of the Orbis database (in Table4.1).

Table 4.1: List of the average values of the dependent variables for the year 2018

Dependent variable	Mean value [k€]
Operating revenues	628
Total assets	504
Current liabilities	198
Non-current liabilities	107

The effect of a 1% increase in the average number of days (therefore an increase from 45 to 46 days in 2018) with temperature lower than the 5^{th} percentile of the probability distribution built on all the same days of the same month from 1981 to 2010, is an average loss of **5.22 k€** in operating revenues and an average reduction in value of total asset of **3.38 k€**. Amplifying the effect of the climate variable, i.e. considering a 10% increase in cold days and not a 1% increase (therefore an increase from 45 to 50 days in 2018), the average loss of operating revenues reaches a value of **48.38 k€** and that of total assets a value of **31.26 k€**. Considering instead the average between the differences in temperature between cold days and the threshold equal to the 10^{th} percentile of the probability distribution, a decrease of one unit of the average causes an average reduction of **63.46 k€** for the non-current liabilities and of **1.66 k€** for the current liabilities; the effect as explained in the previous paragraph is to be considered with a negative dimension: the loss of the capacity to get into debt indicates that the company is not able to grow and increases its performances. The impacts on the company liabilities are slightly more amplified for long-term debt than short-term debt, as can be seen by comparing the numerical values.

The same effects were also evident when considering extremely hot days. The effect of a 1% increase in the average number of days (therefore an increase from 155 to 157 days in 2018) with temperature higher than the 95^{th} percentile of the probability distribution built on all the same days of the same month from 1981 to 2010, is an average loss of **7.60 k€** in operating revenues and an average reduction in value of total asset of **6.81 k€**. Amplifying the effect of the climate variable, i.e. considering a 10% increase in cold days and not a 1% increase (therefore an increase from 155 to 171 days in 2018), the average loss of operating revenues reaches a value of **69.25 k€** and that of total assets a value of **61.41 k€**. Considering instead the average between the differences in temperature between hot days and the threshold equal to the 90^{th} percentile of the probability distribution, a decrease of one unit of the average causes an average reduction of **85.12 k€** for the non-current liabilities and of **10.81 k€** for the current liabilities. Also in this case the impacts on the company liabilities are slightly more amplified for long-term debt than short-term debt. It can also be seen by comparing the numerical values that the impact of extremely hot temperatures is much greater than that of cold temperatures. This can be explained by the fact that we are referring to the transport sector; a sudden increase in hot temperatures can, for example, lead to problems with the transport of damaged food, or to the expansion of railway tracks causing a reduction in the speed originally planned along the route[29].

The effect of a 1% increase in the average total rainfall in 2018 (therefore an increase from 686 to 693 mm in 2018) is not so impactful on the economic variables. What we deduce is that it is an unreliable variable to be considered with respect to the aggregate data because it is very dependent on the territoriality. It makes no sense to treat the aggregate data of a climate variable that depends too much on regionality.

The effect of a 1% increase in the average solar radiation in 2018 (therefore an increase from 121 to 122 W/m^2 in 2018) is an average loss of **2.33 k€** in operating revenues, an average reduction in value of current liabilities of **1.21 k€** and an average reduction in value of non-current liabilities of **0.73 k€**. The climate variable does not have a negative impact on total assets. Amplifying the effect of the climate variable, i.e. considering a 10% increase in the average solar radiations and not a 1% increase (therefore an increase from 121 to 133 W/m^2 in 2018), the average loss reaches a value of **21.87 k€** for operating revenues, **11.30 k€** for current liabilities and **6.81 k€** for non-current liabilities. It can be noted that the effects due to an increase in solar radiation are quantitatively less than the effects due to an increase in days considered extremely hot, and therefore an increase in temperatures; this is due to the fact that the increase in temperature is not only caused by solar radiation but also by other factors such as greenhouse gas emissions.

[29]for further information visit:
`https://www.lastampa.it/cultura/2007/07/21/news/troppo-caldo-i-binari-si-dilatano-1.37126021`

Two summary tables are defined below (Table4.2 and Table4.3) with all the average losses for SMEs in 2018 due to a variations in climate variables.

Table 4.2: Average losses in k€ due to 1% increase in *ex_ cold_ count*, *ex_ hot_ count*, *qqm* and a unit increase in *cold_ mean* and *hot_ mean*

	mean [k€]	corporate losses [k€]				
		ex_cold_count	ex_hot_count	cold_mean	hot_mean	qqm
operating revenues	628.37	5.22	7.60	-	-	2.32
total assets	504.15	3.38	6.81	-	-	-
current liabilities	198.19	-	-	63.46	85.12	1.21
non-current liabilities	106.91	-	-	1.66	10.81	0.73

Table 4.3: Average losses in k€ due to 10% increase in *ex_ cold_ count*, *ex_ hot_ count*, *qqm* and a unit increase in *cold_ mean* and *hot_ mean*

	mean [k€]	corporate losses [k€]				
		ex_cold_count	ex_hot_count	cold_mean	hot_mean	qqm
operating revenues	628.37	48.38	69.25	-	-	21.87
total assets	504.15	31.26	61.41	-	-	-
current liabilities	198.19	-	-	63.46	85.12	11.30
non-current liabilities	106.91	-	-	1.66	10.81	6.81

4.10 Attachments

Data used for the impact analysis on SMEs are confidential, belonging to the Observatory Climate Finance, therefore they cannot be shared.

Chapter 5

Final conclusions

This work has been developed with the aim of demonstrating the existence of relationships between climate effects, defined as anomalous and extreme, and some economic variables related to small and medium enterprises in the transport sector. In support of this theory, several regression models have been realized to highlight such dependencies, through the analysis of a database kindly granted by the Climate Finance Observatory of the Polytechnic University of Milan.

The results of the constructed regression models show that the consequences of climatic events, considered anomalous wings, have a non-negligible effect on economic variables of profitability and balance sheet indices. This suggests that mitigation actions must be taken in order not to destroy the wealth of the most affected areas and to convert international carbon dependence into an opportunity for a full transition to innovative and green solutions.

In this regard, however, Governments should not impose laws and directives that are too stringent, as they could hinder the progress of emerging countries, making certain sectors obsolete. These conclusions have been conducted taken into account several studies in recent years on the impact of certain stringent regulations on certain sectors at risk. Our study highlighted a high level of compliance by the European Union, as an aggregate, with the targets and objectives promoted for climate change mitigation. Specifically, the objectives imposed in the plan of strategies of the last decade has been well achieved by the majority of member states.

Governments must find the right compromise to ensure strong and disruptive mitigation actions that do not damage the welfare and balance of those corporate minorities who cannot afford a total restructuring of their production system. In this regard, concrete and targeted aid must be guaranteed to prevent phenomena such as carbon leakage and bankruptcy from being the result of unbalanced strategies and laws on the national and international territory.

In conclusion, the problem of climate change is a priority that we must face as a community, in all aspects necessary. *"Climate change is real; it is happening right now. It is the most urgent threat facing our entire species, and we need to work collectively together and stop procrastinating."* [Leonardo DiCaprio]

Annexes

Annex I - List of the main EU Climate Change policies

Name of the policy	Binding / Non	Instrument	Sector	Released	Last amendment	Identification code
A hydrogen strategy for a climate-neutral Europe	N	EU Commission's strategy	Industry	2020 July		COM(2020) 301
Clean Planet For All	N	EU Commission's strategy	Environment	2018 November		COM(2018) 773
A European Strategy for Low-Emission Mobility	N	EU Commission's strategy / Standard definition / Ince	Transportation	2016 July		COM(2016) 501
2030 framework for climate and energy policies	N	EU Commission's strategy / Targets for all MS	Energy	2014 October		COM(2014) 15
Regulation on the establishment of a framework to facilitate sustainable investment	B	Standards and obbligations	Industry	2020 June		Regulation (EU) 2020/852
Regulation on sustainability-related disclosures in the financial services sector	B	Standards and obbligations	Financial services	2019 November	2020 June	Regulation (EU) 2019/2088
Eco-design (establishing a framework for the setting of ecodesign requirements for energy-related products)	B	Standards and obbligations	Design	2005 December	2020 January	Directive (EU) 2009/125
Regulation setting CO2 emission performance standards for new passenger cars and for new light commercial vehicles	B	Standards and obbligations	Transportation	2019 April	2020 January	Regulation (EU) 2019/631
Clean and energy-efficient road transport vehicles	B	Standards and obbligations	Transportation	2009 April	2019 June	Directive (EU) 2019/1161
Energy Efficiency	B	Standards and obbligations	Energy	2012 December	2019 June	Directive (EU) 2012/27
Common rules for the internal market for electricity	B	Standards and obbligations	Energy	2019 June		Directive (EU) 2019/944
Revision of the EU Emission Trading System (EU ETS)	B	Standards and obbligations	Industry	2009 December	2018 December	Directive (EU) 2018/410
Governance of the Energy Union and Climate Action	B	Standards and obbligations	Energy	2018 December		Regulation (EU) 2018/1999
Directive on the promotion of the use of energy from renewable sources	B	Standards and obbligations	Energy	2018 December		Directive (EU) 2018/2001
Mechanism for monitoring and reporting greenhouse gas emissions	B	Administrative arrangement	Environment	2013 May	2018 December	Regulation (EU) 2013/525
Binding annual greenhouse gas emission reductions by Member States from 2021 to 2030	B	Binding targets	Industry	2018 May		Regulation (EU) 2018/842
Energy performance of buildings	B	Standards and obbligations	Buildings	2010 May	2018 May	Directive (EU) 2010/31
EU Emission Trading Scheme (EU ETS)	B	Standards and obbligations	Industry	2003 October	2018 March	Directive (EU) 2003/87
Energy labelling	B	Standards and obbligations	Energy	2010 June	2017 July	Regulation (EU) 2017/1369
Reduction of national emissions of certain atmospheric pollutants	B	Standards and obbligations	Environment	2016 December		Directive (EU) 2016/2284
Fuel Quality	B	Standards and obbligations	Transportation	2009 April	2015 September	Directive (EU) 2015/1513
Deployment of alternative fuels infrastructure	B	Infrastructure design	Transportation	2014 October		Directive (EU) 2014/94
Regulation on structure, format, submission processes and review of information reported by MS	B	Reporting requirements		2014 June		Regulation (EU) 2014/749
Clean Sky 2 Joint Undertaking	B	R&D	Transportation	2014 May		Regulation (EU) 2014/558
Fluorinated greenhouse gases	B	Standards and obbligations	Environment	2014 April		Regulation (EU) 2014/517
Common Agricultural Policy 2014-2020	B	Standards and obbligations	Environment	2013 December		Regulations (EU) 2013/1305, 2013/1306, 2013/1307, 2013/1308
The Connecting Europe Facility	B	Standards and obbligations	Transportation	2013 December		Regulation (EU) 2013/1316
Programme for the Environment and Climate Action (LIFE)	B	Standards and obbligations	Environment	2013 December		Regulation (EU) 2013/1293
Labelling of tyres with respect to fuel efficiency and other essential parameters	B	Standards and obbligations	Transportation	2009 November		Regulation (EU) 2009/1222
Geological storage of carbon dioxide	B	R&D	Environment	2009 January		Directive (EU) 2009/31
Community energy-efficiency labelling programme for office equipment	B	Standards and obbligations	Energy	2008 January		Regulation (EU) 2008/106

Annex II - GHG Emissions

EU Countries	GHG Emissions [Mt CO2e] 1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Austria	79,4	83,2	76,6	76,9	77,2	80,7	84,1	83,7	83,1	81,5	82,0	85,8	87,5	93,0	92,9	94,4	92,1	89,5	89,0	82,1	86,7
Belgium	149,6	151,7	151,3	150,3	154,9	157,4	161,6	153,4	159,0	153,3	154,4	152,4	151,7	152,3	153,1	149,9	147,1	143,8	144,1	131,0	138,5
Bulgaria	102,5	84,0	78,6	77,9	74,0	75,5	75,4	72,4	68,3	60,9	59,8	63,0	60,3	65,0	64,1	64,7	65,2	69,1	67,8	58,6	61,2
Croatia	32,4	25,1	23,1	23,2	22,4	23,0	23,5	24,8	25,2	26,3	25,9	27,1	28,2	29,7	29,7	30,2	30,6	32,0	31,1	28,7	28,3
Cyprus	6,4	7,1	7,5	7,7	7,9	7,9	8,3	8,3	8,7	9,0	9,3	9,4	9,6	10,0	10,2	10,2	10,4	10,8	11,0	10,7	10,4
Czechia	199,6	181,1	174,6	166,9	159,4	158,5	161,4	156,9	150,8	141,1	151,2	151,3	147,4	150,8	152,0	150,0	151,2	153,0	148,3	139,2	141,8
Denmark	72,6	83,1	77,2	79,5	83,5	80,5	93,7	84,2	80,4	77,9	73,6	75,2	74,4	79,4	73,6	69,3	77,0	72,4	68,8	65,7	66,0
Estonia	40,4	37,3	27,2	21,3	21,9	20,2	20,8	20,5	19,0	17,7	17,3	17,7	17,1	19,0	19,4	19,2	18,4	22,2	20,1	16,6	21,1
Finland	72,2	70,0	68,4	70,6	76,2	72,7	78,7	77,4	73,8	73,2	71,3	76,7	79,1	86,8	83,2	71,2	82,7	81,3	73,3	69,5	77,4
France	556,9	583,9	573,5	551,2	546,2	553,7	572,0	565,0	579,5	572,9	567,2	571,9	565,1	570,2	569,2	570,7	559,4	549,6	542,0	521,5	527,9
Germany	1261,6	1214,4	1165,2	1157,3	1138,8	1136,4	1155,3	1120,8	1096,0	1063,6	1063,0	1077,7	1056,3	1054,3	1038,7	1016,4	1025,0	999,2	1002,3	934,2	966,9
Greece	105,8	105,5	106,9	106,6	109,8	112,0	115,0	119,8	125,6	126,0	129,0	129,9	129,9	134,4	135,2	139,1	135,3	138,1	134,8	127,4	121,1
Hungary	94,5	87,7	77,7	78,5	77,6	75,9	78,2	76,6	76,2	76,8	74,0	75,9	74,2	77,1	76,3	76,2	75,0	73,3	71,4	65,2	65,6
Ireland	56,6	57,2	56,9	57,8	59,0	60,3	62,3	63,9	66,4	67,7	70,1	72,4	70,6	70,8	70,2	72,2	71,7	71,1	70,3	64,0	63,6
Italy	520,4	522,3	521,2	514,4	508,8	535,3	529,7	537,5	550,3	556,3	560,5	562,0	567,1	587,4	593,4	595,1	585,9	579,5	566,6	511,0	522,6
Latvia	26,6	24,7	19,8	16,4	14,4	13,1	13,1	12,5	12,0	11,2	10,6	11,2	11,2	11,4	11,4	11,6	12,1	12,6	12,2	11,5	12,6
Lithuania	48,4	50,5	31,0	24,8	23,4	22,5	23,5	23,0	24,0	21,1	19,6	20,4	20,8	20,9	21,8	22,9	23,3	25,5	24,6	20,2	21,0
Malta	2,8	2,6	2,7	3,3	3,2	3,0	3,1	3,1	3,1	3,2	3,1	3,2	3,2	3,5	3,4	3,2	3,3	3,4	3,4	3,2	3,3
Netherlands	226,3	234,2	235,7	236,9	238,1	239,3	250,6	243,1	244,1	231,3	229,7	229,9	228,2	228,7	231,0	225,7	220,8	219,3	218,8	212,4	224,0
Poland	475,7	463,8	451,2	451,0	445,4	447,5	461,5	451,3	420,9	409,3	396,7	395,7	385,9	399,4	404,9	405,4	421,0	420,8	414,7	395,5	414,4
Portugal	60,2	62,2	66,2	64,6	65,6	70,4	68,0	71,3	76,2	84,5	83,7	83,3	87,6	82,5	85,8	88,0	83,4	81,2	78,9	75,6	71,6
Romania	248,8	205,0	192,1	183,0	180,7	187,9	189,9	184,6	167,2	148,3	143,6	146,6	149,2	154,2	153,0	151,8	152,6	155,0	150,3	128,5	124,7
Slovakia	73,6	64,2	58,5	55,1	52,7	53,4	53,2	53,2	52,6	51,2	49,3	51,6	50,2	50,5	51,4	51,4	51,3	49,6	50,1	45,8	46,5
Slovenia	18,7	17,3	17,4	17,6	18,0	18,7	19,3	19,7	19,5	18,8	19,1	20,0	20,2	19,9	20,2	20,5	20,7	20,9	21,6	19,6	19,6
Spain	294,2	302,3	312,6	301,9	319,0	335,6	328,5	343,4	353,9	382,1	398,4	396,4	414,3	422,8	439,8	455,0	448,4	460,0	425,9	385,2	371,3
Sweden	72,5	72,5	71,9	72,5	75,2	74,6	78,6	73,7	74,2	71,4	70,1	70,8	71,3	71,6	71,3	68,6	68,3	67,4	65,2	60,6	66,6
United Kingdom	809,7	818,9	799,7	781,5	773,4	768,1	791,1	767,1	768,2	740,1	742,5	744,8	724,7	732,6	732,0	726,6	719,7	707,6	686,6	628,9	642,4
EU27+UK	5721,4	5625,5	5458,2	5362,3	5339,9	5394,6	5511,1	5421,4	5387,5	5287,0	5286,0	5333,4	5297,5	5390,7	5401,1	5373,7	5366,0	5322,0	5206,7	4825,2	4930,6

LEGEND	
(yellow)	Data related to EU27 + UK
(light orange)	Countries in a dubious position
(red)	Non virtuos countries
(green)	Virtuos countries

	GHG Emissions [Mt CO2e]																														
	Difference [%] 2010-2020	Linear dec/increasing factor	2011			2012			2013			2014			2015			2016			2017			2018			Difference [%] 1990-2018	2019	TARGET 2020	
EU Countries			Effective	Target	Difference [%]	Effective	Target	Difference [%]	Effective	Target	Difference [%]	Effective	Target	Difference [%]	Effective	Target	Difference [%]	Effective	Target	Difference [%]	Effective	Target	Difference [%]	Effective	Target	Difference [%]		Target	% reduction / increase	Emissions target
Austria	-23,07%	-2,3%	84,5	84,7	-0,24%	81,6	82,7	-1,34%	82,0	80,8	1,42%	78,3	79,0	-0,78%	80,7	77,1	4,57%	81,8	75,4	8,57%	84,3	73,6	14,49%	81,5	71,9	13,32%	2,66%	70,3	-16,00%	66,7
Belgium	-8,23%	-0,8%	128,3	137,4	-6,65%	125,0	136,3	-8,23%	124,9	135,1	-7,61%	119,3	134,0	-10,99%	123,8	132,9	-6,83%	122,6	131,8	-7,01%	122,8	130,7	-6,04%	123,6	129,7	-4,65%	-17,33%	128,6	-15,00%	127,1
Bulgaria	100,89%	10,1%	66,5	67,4	-1,34%	61,4	74,2	-17,22%	56,2	81,7	-31,27%	59,2	89,9	-34,19%	62,5	99,0	-36,92%	60,0	109,0	-44,97%	62,4	120,0	-48,00%	58,6	132,1	-55,65%	-42,84%	145,4	20,00%	123,0
Croatia	26,85%	2,7%	28,0	29,1	-3,68%	26,2	29,9	-12,23%	24,8	30,7	-19,04%	24,1	31,5	-23,59%	24,5	32,3	-24,31%	24,7	33,2	-25,77%	25,5	34,1	-25,27%	24,4	35,0	-30,45%	-24,77%	36,0	11,00%	35,9
Cyprus	-41,18%	-4,1%	10,0	9,9	1,15%	9,5	9,5	-0,51%	8,7	9,1	-4,70%	9,1	8,7	3,70%	9,1	8,4	8,50%	9,7	8,0	20,32%	10,0	7,7	29,44%	9,9	7,4	33,31%	53,81%	7,1	-5,00%	6,1
Czechia	53,38%	5,3%	140,3	149,4	-6,12%	136,0	157,4	-13,58%	130,7	165,8	-21,19%	128,6	174,6	-26,39%	130,0	184,0	-29,34%	131,9	193,8	-31,96%	130,9	204,1	-35,89%	129,4	215,0	-39,83%	-35,18%	226,5	9,00%	217,6
Denmark	-11,98%	-1,2%	60,8	65,2	-6,70%	56,3	64,4	-12,63%	58,0	63,6	-8,87%	54,0	62,9	-14,16%	51,3	62,1	-17,42%	53,5	61,4	-12,78%	51,3	60,6	-15,40%	51,3	59,9	-14,35%	-29,31%	59,2	-20,00%	58,1
Estonia	112,24%	11,2%	21,2	23,5	-9,77%	20,1	26,1	-22,89%	22,0	29,1	-24,32%	21,2	32,3	-34,41%	18,3	36,0	-49,20%	19,8	40,0	-50,53%	21,1	44,5	-52,55%	20,2	49,5	-59,19%	-50,02%	55,0	11,00%	44,8
Finland	-21,58%	-2,2%	69,9	75,7	-7,63%	64,4	74,1	-13,09%	64,9	72,5	-10,49%	60,7	70,9	-14,42%	57,1	69,4	-17,68%	60,1	67,9	-11,51%	57,5	66,4	-13,43%	58,8	65,0	-9,50%	-18,59%	63,6	-16,00%	60,7
France	-9,26%	-0,9%	499,9	523,0	-4,41%	500,0	518,1	-3,49%	501,0	513,3	-2,40%	470,1	508,6	-7,56%	475,0	503,9	-5,74%	475,8	499,2	-4,68%	480,9	494,6	-2,76%	462,8	490,0	-5,55%	-16,90%	485,5	-14,00%	479,0
Germany	12,22%	1,2%	942,8	978,7	-3,67%	949,4	990,7	-4,16%	967,4	1002,8	-3,53%	927,1	1015,0	-8,66%	931,0	1027,4	-9,38%	935,8	1040,0	-10,02%	923,8	1052,7	-12,24%	888,7	1065,5	-16,59%	-29,56%	1078,5	-14,00%	1085,0
Greece	-16,14%	-1,6%	118,3	119,2	-0,72%	114,7	117,2	-2,14%	105,2	115,4	-8,81%	102,1	113,5	-10,01%	98,4	111,7	-11,90%	94,9	109,9	-13,57%	99,0	108,1	-8,36%	96,1	106,3	-9,62%	-9,16%	104,6	-4,00%	101,6
Hungary	58,43%	5,8%	64,0	69,4	-7,84%	60,1	73,5	-18,20%	57,3	77,8	-26,35%	57,9	82,3	-29,61%	61,4	87,1	-29,57%	61,8	92,2	-32,93%	64,5	97,6	-33,95%	64,1	103,3	-37,98%	-32,18%	109,3	10,00%	103,9
Ireland	-28,87%	-2,9%	59,2	61,8	-4,09%	59,5	60,0	-0,80%	59,6	58,3	2,33%	59,6	56,6	5,30%	62,0	54,9	12,77%	64,1	53,4	20,14%	64,1	51,8	23,66%	64,2	50,3	27,68%	13,60%	48,9	-20,00%	45,2
Italy	-13,38%	-1,3%	510,6	515,7	-0,98%	491,4	508,8	-3,42%	456,0	502,0	-9,15%	435,6	495,2	-12,04%	449,1	488,6	-8,09%	446,5	482,1	-7,38%	442,6	475,6	-6,95%	439,3	469,3	-6,39%	-15,59%	463,0	-13,00%	452,7
Latvia	145,81%	14,6%	11,8	14,5	-18,19%	11,7	16,6	-29,63%	11,6	19,0	-38,89%	11,5	21,8	-47,27%	11,5	25,0	-53,82%	11,6	28,6	-59,56%	11,7	32,8	-64,40%	12,2	37,5	-67,51%	-54,05%	43,0	17,00%	31,1
Lithuania	164,72%	16,5%	21,6	24,5	-11,71%	21,6	28,5	-24,34%	20,4	33,2	-38,68%	20,3	38,7	-47,44%	20,6	45,1	-54,20%	20,7	52,5	-60,56%	20,9	61,2	-65,77%	20,6	71,2	-71,01%	-57,36%	83,0	15,00%	55,7
Malta	-11,64%	-1,2%	3,3	3,3	1,68%	3,5	3,2	9,12%	3,2	3,2	1,02%	3,3	3,1	4,06%	2,6	3,1	-15,97%	2,3	3,1	-24,31%	2,6	3,0	-14,64%	2,7	3,0	-11,15%	-3,86%	3,0	5,00%	2,9
Netherlands	-15,15%	-1,5%	210,3	220,6	-4,66%	206,0	217,3	-5,19%	205,8	214,0	-3,81%	198,5	210,8	-5,80%	207,4	207,6	-0,11%	207,2	204,4	1,37%	205,4	201,3	2,05%	200,5	198,3	1,10%	-11,42%	195,3	-16,00%	190,1
Poland	30,88%	3,1%	413,4	427,2	-3,22%	406,0	440,4	-7,79%	402,7	454,0	-11,30%	390,2	468,0	-16,62%	393,6	482,4	-18,42%	402,3	497,3	-19,11%	417,2	512,7	-18,62%	415,9	528,5	-21,31%	-12,58%	544,8	14,00%	542,3
Portugal	-15,10%	-1,5%	70,3	70,5	-0,33%	68,4	69,5	-1,48%	66,6	68,4	-2,61%	66,7	67,4	-1,00%	71,0	66,4	7,04%	69,4	65,4	6,21%	74,5	64,4	15,74%	71,6	63,4	12,89%	18,90%	62,4	1,00%	60,8
Romania	137,46%	13,7%	129,5	141,8	-8,72%	126,0	161,3	-21,86%	116,5	183,5	-36,51%	116,8	208,7	-44,02%	117,1	237,4	-50,66%	115,2	270,0	-57,35%	117,9	307,1	-61,62%	116,5	349,4	-66,65%	-53,16%	397,4	19,00%	296,1
Slovakia	78,67%	7,9%	45,8	50,2	-8,68%	43,3	54,1	-20,02%	43,0	58,4	-26,43%	40,9	63,0	-35,07%	42,0	68,0	-38,23%	42,5	73,3	-42,06%	43,6	79,1	-44,81%	43,5	85,3	-48,96%	-40,84%	92,0	13,00%	83,2
Slovenia	-1,14%	-0,1%	19,6	19,6	0,14%	19,1	19,6	-2,62%	18,4	19,6	-6,04%	16,6	19,5	-14,80%	16,8	19,5	-13,79%	17,7	19,5	-9,37%	17,4	19,5	-10,43%	17,6	19,5	-9,49%	-5,65%	19,4	4,00%	19,4
Spain	-28,69%	-2,9%	371,8	360,6	3,09%	364,1	350,3	3,94%	337,9	340,2	-0,68%	340,5	330,5	3,05%	352,5	321,0	9,81%	342,7	311,8	9,93%	357,4	302,8	18,01%	352,2	294,1	19,75%	19,74%	285,7	-10,00%	264,7
Sweden	-9,61%	-1,0%	62,4	66,0	-5,35%	59,5	65,3	-8,94%	57,9	64,7	-10,55%	56,1	64,1	-12,39%	55,9	63,5	-11,86%	55,8	62,9	-11,15%	55,5	62,3	-10,84%	54,6	61,7	-11,44%	-24,72%	61,1	-17,00%	60,2
United Kingdom	5,89%	0,6%	596,6	646,1	-7,67%	612,4	649,9	-5,78%	599,0	653,8	-8,38%	559,0	657,6	-15,00%	541,7	661,5	-18,10%	516,3	665,4	-22,40%	507,7	669,3	-24,15%	498,7	673,2	-25,92%	-38,41%	677,2	-16,00%	680,2
EU27+UK	-7,17%	-0,7%	4774,2	4895,3	-2,47%	4710,3	4860,2	-3,08%	4613,8	4825,3	-4,38%	4439,4	4790,7	-7,33%	4478,5	4756,4	-5,84%	4458,2	4722,3	-5,59%	4484,4	4688,4	-4,35%	4391,8	4654,8	-5,65%	-23,24%	4621,4	-20,00%	4577,1

LEGEND	
(yellow)	Data related to EU27 + UK
(light orange)	Countries in a dubious position
(red)	Non virtuos countries
(green)	Virtuos countries

Annex III - EU ETS Compliance with targets

EU Countries + Iceland, Lechtenstein, Norway	Total allocated allowances in all stationary installations (EUA or EUAA) [Mt CO2-eq]									
	First Phase			Second Phase						Linear reduction factor
	2005	2006	2007	2008	2009	2010	2011	2012	Mid point 2008-2012	
Austria	32,4	32,6	32,7	30,7	30,7	31,0	31,0	31,0	31,0	1,74%
Belgium	58,3	60,0	60,4	55,4	56,8	56,0	56,6	68,1	56,0	1,74%
Bulgaria	0,0	0,0	39,7	38,3	40,6	35,3	41,5	42,9	35,3	1,74%
Croatia	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,74%
Cyprus	5,5	5,6	5,9	4,8	5,1	5,4	5,8	6,2	5,4	1,74%
Czechia	96,9	96,9	96,9	85,6	85,9	86,1	86,4	89,0	86,1	1,74%
Denmark	37,3	32,3	27,9	23,9	23,8	23,8	23,8	26,9	23,8	1,74%
Estonia	16,7	18,2	21,3	11,7	11,9	11,9	15,9	14,2	11,9	1,74%
Finland	44,7	44,6	44,6	36,5	37,1	37,9	38,0	38,2	37,9	1,74%
France	150,4	150,0	149,8	129,6	128,6	133,2	134,1	134,5	133,2	1,74%
Germany	493,5	495,5	497,3	436,9	431,9	440,7	440,5	471,6	440,7	1,74%
Greece	71,2	71,2	71,2	63,7	63,2	64,6	76,0	74,0	64,6	1,74%
Hungary	30,2	31,4	31,4	25,1	23,6	25,7	24,9	32,4	25,7	1,74%
Iceland	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,74%
Ireland	19,2	20,5	19,2	20,0	20,1	21,2	21,8	21,8	21,2	1,74%
Italy	216,2	205,1	203,3	212,2	209,0	200,0	195,3	192,7	200,0	1,74%
Latvia	4,1	4,1	4,0	3,7	4,9	4,8	4,6	5,0	4,8	1,74%
Liechtenstein	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,74%
Lithuania	13,5	10,6	10,9	7,5	7,6	8,2	8,9	10,9	8,2	1,74%
Luxembourg	3,2	3,2	3,2	2,5	2,5	2,5	2,5	2,5	2,5	1,74%
Malta	2,1	2,2	2,3	2,1	2,1	2,2	2,2	2,2	2,2	1,74%
Netherlands	86,5	86,4	86,5	76,8	83,8	92,8	92,8	91,0	92,8	1,74%
Norway	0,0	0,0	0,0	7,5	20,6	14,3	14,8	18,2	14,3	1,74%
Poland	237,6	237,6	237,5	201,0	202,0	205,6	207,2	213,0	205,6	1,74%
Portugal	36,9	36,9	36,9	30,4	30,8	32,4	33,0	32,9	32,4	1,74%
Romania	0,0	0,0	74,3	71,8	73,9	75,0	74,8	75,8	75,0	1,74%
Slovakia	30,5	30,5	30,5	32,2	32,1	32,4	32,6	33,4	32,4	1,74%
Slovenia	9,1	8,7	8,2	8,2	8,2	8,2	8,2	8,2	8,2	1,74%
Spain	172,2	166,2	159,7	154,2	151,5	150,0	151,4	154,1	150,0	1,74%
Sweden	22,3	22,5	22,8	20,8	21,1	23,5	22,6	22,6	23,5	1,74%
United Kingdom	206,1	206,0	2015,9	217,8	240,1	256,1	253,8	255,9	256,1	1,74%
EU27 + UK	2096,4	2078,5	3994,6	2003,3	2028,9	2066,4	2086,4	2150,9	2066,4	1,74%

EU Countries + Iceland, Lechtenstein, Norway	Total allocated allowances in all stationary installations (EUA or EUAA) [Mt CO2-eq]																				
	Third Phase																				
	2013			2014			2015			2016			2017			2018			2019		
	Target	Effective	Gap (%)	Target	Effective	Gap (%)	Target	Effective	Gap (%)	Target	Effective	Gap (%)	Target	Effective	Gap (%)	Target	Effective	Gap (%)	Target	Effective	Gap (%)
Austria	30,4	36,8	17,28%	29,9	30,7	2,76%	29,4	31,1	5,53%	28,9	31,7	8,86%	28,4	33,6	15,61%	27,9	32,9	15,19%	27,4	26,1	-4,84%
Belgium	55,1	63,2	12,90%	54,1	52,2	-3,62%	53,2	52,6	-1,09%	52,2	54,5	4,19%	51,3	58,3	11,98%	50,4	56,8	11,20%	49,5	46,3	-6,95%
Bulgaria	34,7	37,1	6,51%	34,0	25,8	-32,14%	33,5	33,5	0,18%	32,9	32,4	-1,33%	32,3	35,8	9,75%	31,7	35,6	10,79%	31,2	28,0	-11,53%
Croatia	0,0	5,3	100,00%	0,0	5,1	100,00%	0,0	16,2	100,00%	0,0	8,5	100,00%	0,0	9,3	100,00%	0,0	9,0	100,00%	0,0	7,3	100,00%
Cyprus	5,3	4,0	-30,66%	5,2	3,4	-51,10%	5,1	3,1	-67,02%	5,0	2,7	-85,25%	4,9	3,4	-43,45%	4,8	3,8	-27,43%	4,8	2,9	-65,97%
Czechia	84,6	70,9	-19,34%	83,1	56,4	-47,28%	81,7	56,6	-44,41%	80,2	59,5	-34,81%	78,9	66,5	-18,64%	77,5	65,3	-18,67%	76,1	48,3	-57,65%
Denmark	23,4	25,1	6,78%	23,0	19,0	-20,94%	22,6	18,9	-19,77%	22,2	19,2	-15,66%	21,8	20,8	-4,81%	21,4	20,1	-6,81%	21,1	14,0	-50,95%
Estonia	11,6	12,9	9,61%	11,4	9,3	-23,59%	11,2	9,8	-15,08%	11,1	10,4	-6,72%	10,9	11,7	7,15%	10,7	12,2	12,79%	10,5	8,8	-18,89%
Finland	37,3	40,1	7,09%	36,6	32,2	-13,63%	36,0	32,1	-12,06%	35,4	32,4	-9,16%	34,7	34,5	-0,78%	34,1	33,2	-2,81%	33,5	24,8	-35,10%
France	130,9	138,9	5,76%	128,6	115,2	-11,67%	126,4	116,9	-8,12%	124,2	119,4	-4,02%	122,0	124,8	2,22%	119,9	120,7	0,66%	117,8	95,1	-23,87%
Germany	433,0	375,6	-15,28%	425,5	292,2	-45,62%	418,1	302,8	-38,05%	410,8	315,6	-30,18%	403,6	347,0	-16,34%	396,6	318,2	-24,63%	389,7	268,5	-45,12%
Greece	63,5	50,8	-25,09%	62,4	36,7	-70,22%	61,3	39,5	-55,13%	60,3	42,2	-42,92%	59,2	48,3	-22,51%	58,2	47,6	-22,25%	57,2	34,2	-67,38%
Hungary	25,3	26,4	4,50%	24,8	19,5	-27,27%	24,4	21,1	-15,29%	24,0	22,2	-7,73%	23,5	24,8	5,05%	23,1	24,4	5,19%	22,7	18,7	-21,39%
Iceland	0,0	1,5	100,00%	0,0	1,5	100,00%	0,0	1,5	100,00%	0,0	1,5	100,00%	0,0	1,4	100,00%	0,0	1,4	100,00%	0,0	2,3	100,00%
Ireland	20,9	14,9	-40,01%	20,5	10,7	-91,96%	20,1	12,0	-67,17%	19,8	12,8	-54,75%	19,4	14,3	-35,73%	19,1	14,1	-35,92%	18,8	9,8	-91,62%
Italy	196,5	186,0	-5,63%	193,1	139,5	-38,41%	189,7	141,8	-33,80%	186,4	148,2	-25,75%	183,2	163,7	-11,93%	180,0	160,8	-11,96%	176,9	116,0	-52,43%
Latvia	4,7	5,4	14,04%	4,6	4,1	-11,35%	4,5	4,0	-12,61%	4,4	4,1	-9,55%	4,4	4,4	0,84%	4,3	4,2	-1,84%	4,2	3,2	-32,29%
Liechtenstein	0,0	0,0	-733,67%	0,0	0,0	-815,23%	0,0	0,0	-915,06%	0,0	0,0	-1040%	0,0	0,0	-1201%	0,0	0,0	-1413%	0,0	0,0	27,04%
Lithuania	8,0	11,9	32,69%	7,9	9,5	17,04%	7,7	10,1	23,03%	7,6	10,1	24,76%	7,5	11,4	34,19%	7,3	10,8	31,98%	7,2	8,5	15,13%
Luxembourg	2,4	2,6	6,38%	2,4	2,1	-16,12%	2,4	2,2	-8,65%	2,3	2,2	-3,37%	2,3	2,4	6,16%	2,2	2,4	5,98%	2,2	1,9	-17,97%
Malta	2,1	1,1	-101,98%	2,1	0,6	-222,49%	2,0	0,7	-179,48%	2,0	0,8	-145,78%	2,0	1,0	-97,30%	1,9	1,0	-96,61%	1,9	0,6	-208,51%
Netherlands	91,2	84,0	-8,66%	89,6	69,4	-29,10%	88,1	70,8	-24,35%	86,5	72,1	-20,07%	85,0	77,4	-9,87%	83,6	76,1	-9,87%	82,1	60,0	-36,78%
Norway	14,1	17,7	20,38%	13,8	17,4	20,40%	13,6	17,1	20,38%	13,4	17,1	21,90%	13,1	16,3	19,43%	12,9	16,0	19,39%	12,7	34,2	62,96%
Poland	202,1	186,9	-8,08%	198,5	134,0	-48,17%	195,1	116,7	-67,21%	191,7	110,6	-73,39%	188,4	157,6	-19,49%	185,1	144,4	-28,17%	181,9	165,5	-9,91%
Portugal	31,8	30,6	-3,83%	31,2	23,3	-34,23%	30,7	24,1	-27,32%	30,2	25,3	-19,08%	29,6	28,2	-5,03%	29,1	27,8	-4,90%	28,6	21,1	-35,94%
Romania	73,7	73,9	0,23%	72,4	46,8	-54,55%	71,1	55,1	-29,18%	69,9	66,3	-5,49%	68,7	72,4	5,15%	67,5	67,5	0,01%	66,3	51,3	-29,39%
Slovakia	31,8	32,3	1,62%	31,2	25,6	-22,17%	30,7	26,1	-17,68%	30,2	26,9	-12,22%	29,6	29,0	-2,30%	29,1	28,7	-1,64%	28,6	23,3	-22,57%
Slovenia	8,1	6,8	-18,11%	7,9	5,2	-53,50%	7,8	5,3	-46,77%	7,7	5,4	-40,76%	7,5	6,2	-22,49%	7,4	6,0	-22,85%	7,3	4,3	-68,19%
Spain	147,4	156,2	5,64%	144,8	116,0	-24,86%	142,3	122,4	-16,25%	139,8	129,3	-8,12%	137,4	143,6	4,34%	135,0	140,9	4,21%	132,7	107,5	-23,44%
Sweden	23,1	38,2	39,52%	22,7	33,1	31,22%	22,3	32,0	30,20%	21,9	31,6	30,52%	21,6	31,9	32,42%	21,2	30,4	30,32%	20,8	25,7	19,04%
United Kingdom	251,7	174,1	-44,54%	247,3	131,5	-88,12%	243,0	136,0	-78,64%	238,8	139,9	-70,62%	234,6	159,0	-47,60%	230,5	152,4	-51,27%	226,5	49,3	-359%
EU27 + UK	2030,5	1892,1	-7,31%	1995,2	1449,0	-37,69%	1960,4	1493,5	-31,27%	1926,3	1536,4	-25,38%	1892,8	1721,2	-9,97%	1859,9	1647,1	-12,91%	1827,5	1271,0	-43,79%

LEGEND	
(yellow)	Data related to EU27 + UK
(light orange)	Data not considered
(red)	Target not reached
(green)	Virtuos countries

Annex IV - EU ETS Percentage of free allowances over total allocated allowances

% Free allowances over total allowances — EU Countries + Iceland, Lechtenstein, Norway

First Phase

Country	2005 Total allowances	2005 Free allowances	2005 % free over total	2006 Total allowances	2006 Free allowances	2006 % free over total	2007 Total allowances	2007 Free allowances	2007 % free over total
Austria	32,4	32,4	100,00%	32,6	32,6	100,00%	32,7	32,7	100,00%
Belgium	58,3	58,3	100,00%	60,0	60,0	100,00%	60,4	60,4	100,00%
Bulgaria							39,7		
Croatia									
Cyprus	5,5	5,5	100,00%	5,6	5,6	100,00%	5,9	5,9	100,00%
Czechia	96,9	96,9	100,00%	96,9	96,9	100,00%	96,9	96,9	100,00%
Denmark	37,3	37,3	100,00%	32,3	27,9	86,46%	27,9	27,9	100,00%
Estonia	16,7	16,7	100,00%	18,2	18,2	100,00%	21,3	21,3	100,00%
Finland	44,7	44,7	100,00%	44,6	44,6	100,00%	44,6	44,6	100,00%
France	150,4	150,4	100,00%	150,0	150,0	100,00%	149,8	149,8	100,00%
Germany	493,5	493,5	100,00%	495,5	495,5	100,00%	497,3	497,3	100,00%
Greece	71,2	71,2	100,00%	71,2	71,2	100,00%	71,2	71,2	100,00%
Hungary	30,2	30,2	100,00%	31,4	30,2	96,19%	31,4	30,2	96,25%
Iceland									
Ireland	19,2	19,2	100,00%	20,5	19,2	94,07%	19,2	19,2	100,00%
Italy	216,2	216,2	100,00%	205,1	205,1	100,00%	203,3	203,3	100,00%
Latvia	4,1	4,1	100,00%	4,1	4,1	100,00%	4,0	4,0	100,00%
Liechtenstein									
Lithuania	13,5	13,5	100,00%	10,6	10,6	100,00%	10,9	10,3	94,92%
Luxembourg	3,2	3,2	100,00%	3,2	3,2	100,00%	3,2	3,2	100,00%
Malta	2,1	2,1	100,00%	2,2	2,2	100,00%	2,3	2,3	100,00%
Netherlands	86,5	86,5	100,00%	86,4	86,4	100,00%	86,5	86,5	100,00%
Norway									
Poland	237,6	237,6	100,00%	237,6	237,6	100,00%	237,5	237,5	100,00%
Portugal	36,9	36,9	100,00%	36,9	36,9	100,00%	36,9	36,9	100,00%
Romania							74,3	74,3	100,00%
Slovakia	30,5	30,5	100,00%	30,5	30,5	100,00%	30,5	30,5	100,00%
Slovenia	9,1	9,1	100,00%	8,7	8,7	100,00%	8,2	8,2	100,00%
Spain	172,2	172,2	100,00%	166,2	166,2	100,00%	159,7	159,7	100,00%
Sweden	22,3	22,3	100,00%	22,5	22,5	100,00%	22,8	22,8	100,00%
United Kingdom	206,1	206,1	100,00%	206,0	206,0	100,00%	215,9	215,9	100,00%
EU27 + UK	2096,4	2096,4	100,00%	2078,5	2071,8	99,67%	2194,6	2153,2	98,11%

Second Phase

Country	2008 Total allowances	2008 Free allowances	2008 % free over total	2009 Total allowances	2009 Free allowances	2009 % free over total	2010 Total allowances	2010 Free allowances	2010 % free over total	2011 Total allowances	2011 Free allowances	2011 % free over total	2012 Total allowances	2012 Free allowances	2012 % free over total
Austria	30,7	30,1	98,12%	30,7	31,9	103,77%	31,0	32,1	103,76%	31,0	32,6	105,38%	31,0	33,4	108,02%
Belgium	55,4	55,4	100,00%	56,8	56,8	100,00%	56,0	56,0	100,00%	56,6	56,6	100,00%	68,1	58,6	85,96%
Bulgaria	38,3	38,3	100,00%	40,6	40,6	100,00%	35,3	35,3	100,00%	41,5	41,5	100,00%	42,9	42,8	99,70%
Croatia															
Cyprus	4,8	4,8	100,00%	5,1	5,1	100,00%	5,4	5,4	100,00%	5,8	5,8	100,00%	6,2	6,2	100,00%
Czechia	85,6	85,6	100,00%	85,9	85,9	100,00%	86,1	86,1	100,00%	86,4	86,4	100,00%	89,0	86,4	97,11%
Denmark	23,9	24,0	100,32%	23,8	23,9	100,32%	23,8	23,9	100,32%	23,8	23,9	100,32%	26,9	24,1	89,72%
Estonia	11,7	11,7	100,00%	11,9	11,9	100,00%	11,9	11,9	100,00%	15,9	15,9	100,00%	14,2	14,2	100,00%
Finland	36,5	36,5	100,00%	37,1	37,1	100,00%	37,9	37,9	100,00%	38,0	38,0	100,00%	38,2	38,2	100,00%
France	129,6	129,6	100,00%	128,6	128,6	100,00%	133,2	138,6	104,06%	134,1	139,5	104,03%	134,5	139,9	104,02%
Germany	436,9	388,8	88,98%	431,9	391,7	90,70%	440,7	400,5	90,88%	440,5	400,8	90,98%	471,6	424,5	90,00%
Greece	63,7	63,7	100,00%	63,2	63,2	100,00%	64,6	64,6	100,00%	76,0	66,0	86,84%	74,0	65,2	88,17%
Hungary	25,1	25,1	100,00%	23,6	23,6	100,00%	25,7	25,7	100,00%	24,9	24,9	100,00%	32,4	24,7	76,29%
Iceland															
Ireland	20,0	20,0	100,00%	20,1	20,0	99,08%	21,2	21,0	99,13%	21,8	21,6	99,14%	21,8	21,8	100,00%
Italy	212,2	212,2	100,00%	209,0	209,0	100,00%	200,0	200,0	100,00%	195,3	195,3	100,00%	192,7	192,7	100,00%
Latvia	3,7	3,7	100,00%	4,9	4,9	100,00%	4,8	4,8	100,00%	4,6	4,6	100,00%	5,0	5,0	100,00%
Liechtenstein	0,0	0,0	100,00%	0,0	0,0	100,00%	0,0	0,0	100,00%	0,0	0,0	100,00%	0,0	0,0	100,00%
Lithuania	7,5	7,5	100,00%	7,6	7,6	100,00%	8,2	8,2	100,00%	8,9	8,0	90,44%	10,9	8,4	77,14%
Luxembourg	2,5	2,5	100,00%	2,5	2,5	100,00%	2,5	2,5	100,00%	2,5	2,5	100,00%	2,5	2,5	99,84%
Malta	2,1	2,1	100,00%	2,1	2,1	100,00%	2,2	2,2	100,00%	2,2	2,2	100,00%	2,2	2,2	100,00%
Netherlands	76,8	76,8	100,00%	83,8	83,8	100,00%	92,8	84,8	91,38%	92,8	88,8	95,69%	91,0	87,0	95,60%
Norway	7,5	7,5	100,00%	20,6	8,0	38,73%	14,3	8,0	55,82%	14,8	8,4	57,09%	18,2	8,4	46,34%
Poland	201,0	201,0	100,00%	202,0	202,0	100,00%	205,6	205,6	100,00%	207,2	207,2	100,00%	213,0	212,8	99,90%
Portugal	30,4	30,4	100,00%	30,8	30,8	100,00%	32,4	32,4	100,00%	33,0	33,0	100,00%	32,9	32,9	100,00%
Romania	71,8	71,8	100,00%	73,9	73,9	100,00%	75,0	75,0	100,00%	74,8	74,8	100,00%	75,8	75,2	99,16%
Slovakia	32,2	32,2	100,00%	32,1	32,1	100,00%	32,4	32,4	100,00%	32,6	32,6	100,00%	33,4	33,4	100,00%
Slovenia	8,2	8,2	100,00%	8,2	8,2	100,00%	8,2	8,2	100,00%	8,2	8,2	100,00%	8,2	8,2	100,00%
Spain	154,2	153,9	99,83%	151,5	150,8	99,54%	150,0	151,0	100,64%	151,4	151,4	100,00%	154,1	154,1	100,00%
Sweden	20,8	20,8	100,00%	21,1	21,1	100,00%	23,5	23,5	100,00%	22,6	22,6	100,00%	22,6	22,6	100,00%
United Kingdom	217,8	213,8	98,16%	240,1	215,1	89,59%	256,1	220,3	86,02%	253,8	223,1	87,91%	255,9	228,6	89,32%
EU27 + UK	2003,3	1950,4	97,36%	2028,9	1964,1	96,81%	2066,4	1989,9	96,29%	2086,4	2008,1	96,25%	2150,9	2045,6	95,10%

LEGEND

- % free allowances > total allowances
- % free allowances = total allowances
- % free allowances < total allowances

- countries which emitted at least for 1y more free allowances than actioned ones
- countries which issued only free allowances in the third trading period

EU Countries + Iceland, Lechtenstein, Norway	% Free allowances over total allowances																				
	Third Phase																				
	2013			2014			2015			2016			2017			2018			2019		
	Total allowances	Free allowances	% free over total	Total allowances	Free allowances	% free over total	Total allowances	Free allowances	% free over total	Total allowances	Free allowances	% free over total	Total allowances	Free allowances	% free over total	Total allowances	Free allowances	% free over total	Total allowances	Free allowances	% free over total
Austria	36,8	22,5	61,05%	30,7	21,9	71,26%	31,1	21,1	67,83%	31,7	20,5	64,71%	33,6	19,9	59,29%	32,9	19,4	58,96%	26,1	18,8	71,86%
Belgium	63,2	37,1	58,68%	52,2	36,1	69,18%	52,6	34,4	65,34%	54,5	34,1	62,65%	58,3	33,4	57,25%	56,8	32,2	56,73%	46,3	32,0	69,00%
Bulgaria	37,1	21,8	58,83%	25,8	19,7	76,27%	33,5	17,7	52,68%	32,4	16,3	50,16%	35,8	13,2	36,87%	35,6	11,8	33,04%	28,0	10,1	36,19%
Croatia	5,3	5,3	100,00%	5,1	5,1	100,00%	16,2	4,8	29,93%	8,5	4,7	55,24%	9,3	4,6	49,50%	9,0	4,4	49,05%	7,3	4,3	59,80%
Cyprus	4,0	3,7	92,40%	3,4	3,4	97,89%	3,1	3,1	100,00%	2,7	2,7	100,00%	3,4	2,4	68,92%	3,8	2,2	57,81%	2,9	1,9	65,41%
Czechia	70,9	52,3	73,75%	56,4	47,0	83,30%	56,6	42,1	74,43%	59,5	37,2	62,45%	66,5	31,8	47,91%	65,3	27,5	42,10%	48,3	22,7	47,08%
Denmark	25,1	12,2	48,68%	19,0	11,1	58,21%	18,9	9,9	52,32%	19,2	9,1	47,64%	20,8	8,5	40,89%	20,1	7,9	39,56%	14,0	7,3	52,62%
Estonia	12,9	8,8	68,26%	9,3	8,0	86,56%	9,8	7,0	71,68%	10,4	5,9	56,74%	11,7	4,9	41,68%	12,2	3,2	25,77%	8,8	3,0	34,28%
Finland	40,1	22,9	57,09%	32,2	21,6	67,06%	32,1	20,1	62,58%	32,4	19,0	58,55%	34,5	18,0	52,32%	33,2	17,0	51,20%	24,8	16,0	64,43%
France	138,9	82,6	59,44%	115,2	80,4	69,83%	116,9	77,6	66,35%	119,4	75,4	63,19%	124,8	71,0	56,89%	120,7	67,7	56,05%	95,1	66,2	69,60%
Germany	375,6	169,5	45,13%	292,2	165,1	56,49%	302,8	158,9	52,49%	315,6	154,8	49,05%	347,0	150,1	43,27%	318,2	146,0	45,88%	268,5	141,0	52,50%
Greece	50,8	15,0	29,60%	36,7	14,7	39,97%	39,5	14,6	36,91%	42,2	14,3	33,91%	48,3	14,2	29,41%	47,6	14,0	29,33%	34,2	13,7	40,13%
Hungary	26,4	18,0	68,19%	19,5	10,0	51,16%	21,1	10,4	48,98%	22,2	10,2	45,80%	24,8	10,0	40,48%	24,4	9,8	40,37%	18,7	9,5	50,79%
Iceland	1,5	1,5	100,00%	1,5	1,5	100,00%	1,5	1,5	100,00%	1,5	1,5	100,00%	1,4	1,4	100,00%	1,4	1,4	100,00%	2,3	1,4	59,60%
Ireland	14,9	5,3	35,34%	10,7	4,7	44,34%	12,0	5,3	44,17%	12,8	5,3	41,23%	14,3	5,1	35,78%	14,1	5,0	35,47%	9,8	4,9	49,54%
Italy	186,0	86,8	46,67%	139,5	78,3	56,14%	141,8	72,5	51,16%	148,2	70,9	47,80%	163,7	68,9	42,12%	160,8	67,4	41,92%	116,0	64,4	55,48%
Latvia	5,4	2,7	49,14%	4,1	2,4	58,61%	4,0	2,1	51,80%	4,1	1,9	46,68%	4,4	1,8	39,87%	4,2	1,6	38,04%	3,2	1,5	46,50%
Liechtenstein	0,0	0,0	100,00%	0,0	0,0	100,00%	0,0	0,0	100,00%	0,0	0,0	100,00%	0,0	0,0	100,00%	0,0	0,0	100,00%	0,0	0,0	4,03%
Lithuania	11,9	6,9	57,81%	9,5	6,6	69,20%	10,1	6,4	63,31%	10,1	6,2	60,95%	11,4	5,9	51,99%	10,8	5,6	51,97%	8,5	5,1	60,00%
Luxembourg	2,6	1,4	52,56%	2,1	1,3	63,08%	2,2	1,3	60,19%	2,2	1,3	56,93%	2,4	1,2	51,30%	2,4	1,2	51,03%	1,9	1,2	63,47%
Malta	1,1			0,6			0,7			0,8			1,0			1,0			0,6		
Netherlands	84,0	49,5	58,92%	69,4	48,2	69,36%	70,8	46,8	66,00%	72,1	45,2	62,67%	77,4	44,5	57,44%	76,1	43,6	57,30%	60,0	42,3	70,51%
Norway	17,7	17,7	100,00%	17,4	17,4	100,00%	17,1	17,1	100,00%	17,1	17,1	100,00%	16,3	16,3	100,00%	16,0	16,0	100,00%	34,2	15,7	45,88%
Poland	186,9	135,7	72,59%	134,0	120,7	90,05%	116,7	99,6	85,32%	110,6	85,0	76,88%	157,6	71,8	45,52%	144,4	66,4	45,97%	165,5	61,6	37,23%
Portugal	30,6	12,5	40,88%	23,3	12,1	52,09%	24,1	11,5	47,60%	25,3	11,2	44,28%	28,2	10,9	38,76%	27,8	10,7	38,64%	21,1	10,7	51,05%
Romania	73,9	40,0	54,21%	46,8	30,4	64,79%	55,1	29,7	53,89%	66,3	29,5	44,50%	72,4	27,2	37,60%	67,5	21,0	31,10%	51,3	20,9	40,72%
Slovakia	32,3	16,5	50,95%	25,6	15,8	61,87%	26,1	15,0	57,62%	26,9	14,5	54,05%	29,0	13,8	47,81%	28,7	13,7	47,98%	23,3	13,4	57,45%
Slovenia	6,8	2,3	33,38%	5,2	2,4	45,75%	5,3	2,1	40,18%	5,4	1,9	34,76%	6,2	1,8	29,27%	6,0	1,7	28,83%	4,3	1,7	38,78%
Spain	156,2	67,3	43,06%	116,0	61,2	52,77%	122,4	60,4	49,30%	129,3	60,0	46,38%	143,6	58,8	40,91%	140,9	57,3	40,63%	107,5	57,7	53,68%
Sweden	38,2	29,1	76,03%	33,1	27,4	82,91%	32,0	25,6	80,01%	31,6	24,4	77,37%	31,9	23,2	72,58%	30,4	21,8	71,63%	25,7	20,7	80,40%
United Kingdom	174,1	66,8	38,34%	131,5	65,2	49,63%	136,0	61,1	44,89%	139,9	59,7	42,65%	159,0	53,0	33,34%	152,4	51,3	33,69%	49,3	49,3	100,00%
EU27 + UK	2102,7	994,3	47,29%	1538,5	920,6	59,84%	1493,5	860,8	57,63%	1536,4	821,1	53,44%	1721,2	770,0	44,74%	1647,1	731,4	44,40%	1271,0	701,9	55,23%

LEGEND	
(dark orange)	% free allowances > total allowances
(yellow)	% free allowances = total allowances
(green)	% free allowances < total allowances

(light orange)	countries which emitted at least for 1y more free allowances than actioned ones
(grey)	countries which issued only free allowances in the third trading period

Annex V - EU ETS Entities by size

EU Countries + Iceland, Lechtenstein, Norway		% of entities belonging to a certain category out of the total														
		First phase														
		2005					2006					2007				
		C	B	A1	A2	Zero	C	B	A1	A2	Zero	C	B	A1	A2	Zero
Austria	% over total	7%	23%	48%	11%	11%	7%	22%	47%	11%	13%	6%	22%	46%	11%	15%
Belgium	% over total	9%	24%	50%	15%	2%	11%	22%	50%	17%	1%	9%	23%	49%	17%	2%
Bulgaria	% over total											13%	19%	58%	10%	1%
Croatia	% over total															
Cyprus	% over total	31%	8%	62%	0%	0%	23%	15%	62%	0%	0%	23%	15%	62%	0%	0%
Czechia	% over total	8%	17%	62%	10%	3%	8%	15%	63%	10%	4%	8%	15%	63%	9%	5%
Denmark	% over total	4%	9%	72%	5%	10%	4%	9%	73%	5%	10%	3%	9%	77%	3%	8%
Estonia	% over total	7%	23%	49%	16%	5%	6%	23%	53%	15%	2%	6%	23%	53%	17%	0%
Finland	% over total	3%	12%	58%	5%	23%	4%	11%	59%	5%	21%	4%	12%	62%	4%	18%
France	% over total	5%	21%	54%	17%	3%	5%	20%	54%	17%	5%	5%	19%	53%	17%	6%
Germany	% over total	9%	19%	56%	14%	2%	9%	20%	56%	13%	1%	9%	20%	57%	12%	2%
Greece	% over total	18%	23%	40%	15%	4%	18%	19%	45%	16%	2%	18%	19%	45%	16%	3%
Hungary	% over total	5%	17%	58%	19%	1%	5%	18%	57%	19%	1%	5%	16%	58%	18%	2%
Iceland	% over total															
Ireland	% over total	12%	13%	63%	13%	0%	13%	12%	63%	8%	4%	12%	14%	64%	7%	3%
Italy	% over total	10%	24%	50%	16%	0%	10%	22%	51%	14%	2%	9%	20%	51%	13%	6%
Latvia	% over total	1%	8%	75%	12%	4%	1%	7%	73%	9%	9%	1%	6%	74%	11%	8%
Liechtenstein	% over total															
Lithuania	% over total	5%	9%	63%	10%	14%	4%	11%	69%	7%	10%	4%	10%	68%	9%	10%
Luxembourg	% over total	13%	53%	13%	20%	0%	13%	60%	13%	13%	0%	13%	47%	13%	27%	0%
Malta	% over total	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
Netherlands	% over total	14%	40%	22%	22%	2%	13%	41%	23%	22%	1%	13%	39%	21%	23%	4%
Norway	% over total															
Poland	% over total	7%	21%	50%	21%	1%	7%	20%	50%	20%	3%	7%	21%	49%	20%	3%
Portugal	% over total	5%	11%	66%	13%	5%	4%	12%	65%	12%	7%	5%	11%	60%	13%	11%
Romania	% over total											13%	23%	48%	12%	4%
Slovakia	% over total	3%	16%	70%	10%	1%	4%	16%	71%	8%	1%	4%	15%	69%	9%	3%
Slovenia	% over total	3%	11%	69%	15%	1%	3%	11%	68%	13%	4%	4%	9%	70%	14%	2%
Spain	% over total	11%	23%	46%	16%	4%	8%	20%	54%	15%	3%	8%	20%	51%	15%	5%
Sweden	% over total	1%	7%	70%	5%	16%	1%	7%	69%	4%	19%	1%	7%	65%	4%	23%
United Kingdom	% over total	9%	18%	55%	8%	10%	9%	17%	55%	6%	13%	7%	16%	43%	5%	29%
EU27 + UK	% over total	7%	19%	56%	13%	6%	7%	18%	56%	13%	6%	7%	18%	55%	12%	9%

EU Countries + Iceland, Lechtenstein, Norway		% of entities belonging to a certain category out of the total																								
		Second phase																								
		2008					2009					2010					2011					2012				
		C	B	A1	A2	Zero	C	B	A1	A2	Zero	C	B	A1	A2	Zero	C	B	A1	A2	Zero	C	B	A1	A2	Zero
Austria	% over total	7%	26%	50%	10%	7%	6%	24%	50%	12%	7%	6%	25%	50%	13%	7%	7%	22%	51%	13%	7%	7%	23%	50%	14%	6%
Belgium	% over total	10%	23%	45%	21%	0%	7%	22%	49%	19%	2%	8%	24%	48%	16%	3%	7%	23%	48%	19%	3%	6%	24%	48%	18%	5%
Bulgaria	% over total	10%	19%	57%	9%	5%	9%	17%	57%	9%	8%	8%	17%	56%	11%	8%	7%	20%	55%	8%	11%	8%	20%	59%	7%	5%
Croatia	% over total																									
Cyprus	% over total	23%	15%	62%	0%	0%	21%	14%	57%	0%	7%	21%	14%	57%	0%	7%	29%	7%	57%	0%	7%	21%	7%	57%	0%	14%
Czechia	% over total	7%	15%	62%	9%	8%	7%	17%	63%	8%	6%	7%	17%	60%	8%	9%	7%	15%	60%	8%	10%	7%	16%	61%	7%	10%
Denmark	% over total	3%	8%	77%	4%	7%	3%	7%	79%	5%	6%	3%	8%	78%	5%	6%	3%	7%	78%	5%	7%	3%	7%	80%	5%	6%
Estonia	% over total	6%	23%	55%	13%	2%	6%	16%	57%	16%	4%	6%	18%	51%	14%	10%	6%	20%	48%	18%	8%	6%	20%	52%	14%	8%
Finland	% over total	3%	11%	60%	4%	21%	3%	11%	59%	4%	22%	4%	11%	62%	4%	19%	4%	11%	64%	4%	18%	2%	11%	63%	5%	19%
France	% over total	5%	19%	53%	17%	6%	5%	18%	54%	16%	7%	5%	18%	51%	16%	10%	5%	18%	53%	15%	9%	4%	20%	54%	17%	5%
Germany	% over total	10%	21%	55%	12%	2%	9%	20%	56%	12%	2%	9%	21%	54%	13%	3%	9%	20%	55%	12%	4%	9%	20%	54%	12%	5%
Greece	% over total	18%	18%	49%	12%	3%	16%	19%	46%	11%	9%	16%	14%	47%	14%	9%	15%	16%	45%	12%	12%	16%	15%	49%	10%	10%
Hungary	% over total	6%	17%	56%	14%	7%	4%	16%	53%	13%	13%	4%	20%	59%	15%	2%	4%	19%	61%	13%	3%	4%	18%	65%	11%	2%
Iceland	% over total																									
Ireland	% over total	14%	15%	62%	8%	1%	12%	16%	61%	9%	1%	12%	16%	59%	12%	1%	10%	17%	61%	11%	1%	10%	14%	62%	10%	4%
Italy	% over total	10%	22%	51%	14%	4%	8%	20%	54%	13%	5%	8%	20%	53%	13%	6%	8%	21%	54%	14%	4%	7%	21%	55%	13%	4%
Latvia	% over total	1%	5%	67%	8%	19%	1%	7%	73%	11%	8%	3%	6%	73%	13%	5%	3%	5%	76%	11%	5%	3%	4%	75%	12%	7%
Liechtenstein	% over total	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%
Lithuania	% over total	4%	7%	62%	11%	17%	4%	8%	64%	11%	14%	3%	10%	59%	13%	16%	3%	12%	61%	9%	16%	3%	9%	61%	10%	16%
Luxembourg	% over total	14%	43%	14%	29%	0%	14%	36%	21%	29%	0%	15%	38%	8%	38%	0%	15%	38%	8%	38%	0%	15%	38%	15%	31%	0%
Malta	% over total	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
Netherlands	% over total	8%	18%	59%	12%	2%	8%	18%	60%	12%	2%	8%	18%	58%	15%	1%	8%	18%	60%	13%	1%	8%	18%	61%	12%	2%
Norway	% over total	11%	32%	49%	7%	2%	11%	30%	49%	6%	3%	10%	32%	45%	8%	4%	11%	32%	46%	6%	6%	10%	30%	48%	7%	5%
Poland	% over total	7%	20%	51%	20%	3%	7%	18%	50%	20%	5%	7%	21%	47%	20%	4%	7%	20%	49%	19%	5%	8%	21%	49%	21%	1%
Portugal	% over total	5%	15%	52%	13%	14%	5%	14%	56%	13%	12%	5%	13%	50%	14%	18%	5%	13%	51%	11%	20%	5%	16%	52%	13%	14%
Romania	% over total	13%	21%	49%	14%	3%	10%	19%	53%	11%	7%	11%	19%	49%	13%	8%	11%	18%	47%	14%	10%	11%	19%	45%	14%	12%
Slovakia	% over total	5%	17%	66%	8%	4%	3%	18%	67%	7%	5%	5%	17%	63%	7%	8%	4%	18%	62%	6%	9%	4%	19%	62%	7%	8%
Slovenia	% over total	4%	10%	73%	13%	0%	3%	10%	77%	8%	2%	3%	9%	70%	12%	7%	3%	9%	74%	10%	3%	3%	8%	75%	9%	5%
Spain	% over total	8%	21%	53%	13%	5%	7%	20%	55%	11%	6%	6%	21%	53%	11%	8%	6%	22%	53%	10%	9%	6%	22%	52%	10%	10%
Sweden	% over total	1%	6%	65%	4%	23%	1%	6%	67%	4%	22%	2%	6%	69%	4%	19%	1%	6%	68%	4%	22%	1%	5%	69%	4%	21%
United Kingdom	% over total	8%	23%	54%	9%	5%	8%	22%	55%	9%	6%	8%	22%	53%	10%	6%	8%	21%	56%	10%	5%	7%	21%	58%	10%	4%
EU27 + UK	% over total	7%	18%	56%	12%	7%	7%	17%	57%	11%	7%	7%	18%	56%	12%	8%	7%	18%	57%	11%	8%	6%	18%	57%	11%	7%

	EU27 + UK MEAN	DEV. ST
C	7%	0,47%
B	19%	0,77%
A1	56%	0,77%
A2	12%	0,78%
Zero	6%	1,30%

LEGEND	
C	Large (emissions > 500 kt CO2-eq)
B	Medium (50 < emissions < 500 kt CO2-eq)
A1	Mini (0 < emissions < 25 kt CO2-eq)
A2	Small (25 < emissions < 50 kt CO2-eq)
Zero	Zero (emissions = 0 kt CO2-eq) [EMISSION FROM BIOMASS]

(yellow)	values > μ + 15 * σ
(grey)	values < μ - 15 * σ
(red)	countries that deviate significantly from the EU27 + UK values

% of entities belonging to a certain category out of the total

Third phase

EU Countries + Iceland, Lechtenstein, Norway

		2013					2014					2015					2016					2017					2018					2019				
		C	B	A1	A2	Zero	C	B	A1	A2	Zero	C	B	A1	A2	Zero	C	B	A1	A2	Zero	C	B	A1	A2	Zero	C	B	A1	A2	Zero	C	B	A1	A2	Zero
Austria	% over total	5%	27%	46%	19%	3%	4%	26%	48%	18%	4%	5%	27%	47%	17%	4%	5%	28%	48%	15%	3%	5%	27%	47%	16%	4%	5%	26%	47%	17%	5%	4%	27%	48%	16%	5%
Belgium	% over total	6%	21%	54%	18%	2%	5%	22%	52%	18%	2%	6%	21%	52%	20%	1%	6%	23%	50%	19%	2%	6%	24%	50%	20%	1%	6%	24%	50%	19%	1%	7%	24%	48%	20%	1%
Bulgaria	% over total	10%	20%	51%	13%	7%	11%	19%	55%	10%	6%	9%	19%	55%	8%	8%	10%	18%	52%	11%	9%	10%	19%	50%	13%	8%	8%	21%	47%	14%	9%	8%	20%	52%	10%	10%
Croatia	% over total	11%	21%	52%	13%	4%	9%	25%	49%	9%	7%	11%	20%	44%	15%	9%	11%	23%	47%	11%	8%	12%	25%	44%	10%	10%	12%	24%	51%	6%	8%	12%	22%	52%	12%	2%
Cyprus	% over total	25%	0%	75%	0%	0%	25%	0%	75%	0%	0%	25%	0%	67%	0%	8%	25%	0%	58%	8%	8%	27%	0%	64%	9%	0%	27%	0%	45%	9%	18%	27%	0%	55%	0%	18%
Czechia	% over total	7%	19%	61%	10%	3%	8%	18%	63%	8%	3%	8%	19%	63%	8%	3%	9%	18%	63%	8%	2%	9%	20%	61%	8%	2%	10%	20%	58%	9%	3%	10%	20%	58%	9%	3%
Denmark	% over total	3%	9%	78%	6%	4%	3%	9%	77%	7%	5%	3%	8%	76%	7%	5%	2%	10%	77%	6%	4%	2%	11%	78%	6%	4%	2%	11%	78%	5%	4%	2%	10%	78%	5%	5%
Estonia	% over total	7%	26%	51%	14%	2%	11%	13%	57%	15%	4%	9%	18%	60%	11%	2%	11%	15%	57%	15%	2%	15%	11%	54%	15%	4%	15%	15%	54%	11%	4%	15%	13%	59%	9%	4%
Finland	% over total	3%	10%	61%	5%	21%	2%	11%	62%	4%	20%	2%	11%	61%	5%	21%	2%	11%	65%	5%	17%	2%	11%	64%	4%	19%	3%	11%	65%	4%	18%	2%	11%	65%	4%	18%
France	% over total	4%	18%	58%	17%	3%	4%	18%	59%	15%	5%	4%	19%	61%	15%	1%	4%	18%	60%	16%	2%	4%	17%	60%	16%	2%	4%	18%	61%	15%	1%	4%	17%	63%	15%	1%
Germany	% over total	8%	22%	51%	15%	5%	8%	22%	52%	14%	4%	8%	22%	53%	14%	4%	8%	22%	51%	14%	5%	8%	23%	51%	15%	4%	7%	22%	52%	15%	4%	7%	22%	53%	15%	4%
Greece	% over total	17%	13%	50%	6%	15%	14%	16%	46%	8%	16%	15%	16%	47%	9%	13%	18%	13%	43%	11%	15%	19%	15%	42%	10%	15%	18%	15%	42%	10%	15%	23%	15%	44%	10%	7%
Hungary	% over total	3%	20%	62%	10%	4%	4%	19%	68%	7%	1%	4%	20%	65%	10%	1%	4%	20%	62%	12%	2%	5%	19%	63%	12%	1%	4%	19%	64%	12%	1%	6%	16%	65%	12%	1%
Iceland	% over total	20%	60%	20%	0%	0%	20%	60%	20%	0%	0%	33%	33%	33%	0%	0%	29%	29%	43%	0%	0%	25%	25%	25%	13%	13%	22%	33%	22%	0%	22%	25%	38%	25%	0%	13%
Ireland	% over total	10%	16%	63%	10%	1%	10%	16%	61%	13%	0%	11%	14%	64%	12%	0%	13%	14%	61%	13%	0%	12%	13%	61%	13%	0%	13%	12%	61%	13%	0%	13%	14%	60%	13%	1%
Italy	% over total	5%	20%	55%	14%	6%	4%	20%	55%	14%	6%	6%	20%	57%	16%	1%	6%	21%	56%	16%	1%	7%	21%	54%	18%	1%	7%	22%	54%	17%	1%	8%	21%	54%	17%	1%
Latvia	% over total	3%	3%	71%	12%	12%	3%	3%	82%	6%	6%	3%	3%	82%	6%	6%	3%	3%	83%	6%	5%	2%	5%	84%	5%	5%	3%	3%	84%	5%	5%	3%	3%	81%	5%	8%
Liechtenstein	% over total	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%
Lithuania	% over total	4%	4%	67%	11%	14%	3%	5%	73%	9%	10%	3%	7%	72%	4%	13%	3%	6%	66%	6%	19%	3%	4%	65%	6%	21%	3%	3%	65%	6%	22%	4%	4%	68%	4%	21%
Luxembourg	% over total	6%	33%	39%	22%	0%	5%	30%	50%	15%	0%	5%	30%	50%	15%	0%	5%	25%	55%	15%	0%	5%	24%	57%	14%	0%	5%	23%	64%	9%	0%	5%	23%	59%	14%	0%
Malta	% over total	50%	50%	0%	0%	0%	50%	50%	0%	0%	0%	50%	0%	0%	50%	0%	50%	0%	50%	0%	0%	0%	75%	25%	0%	0%	25%	25%	50%	0%	0%	25%	25%	50%	0%	0%
Netherlands	% over total	8%	23%	52%	16%	1%	8%	23%	54%	13%	1%	9%	22%	55%	13%	1%	9%	22%	53%	15%	2%	9%	22%	54%	15%	0%	9%	23%	55%	13%	1%	9%	21%	56%	14%	0%
Norway	% over total	11%	39%	37%	7%	5%	10%	39%	38%	10%	3%	11%	40%	39%	7%	2%	10%	40%	36%	10%	4%	9%	39%	37%	10%	4%	9%	39%	40%	9%	3%	9%	38%	38%	10%	6%
Poland	% over total	8%	21%	48%	21%	2%	8%	21%	50%	19%	2%	9%	20%	48%	22%	1%	9%	22%	46%	22%	2%	9%	23%	43%	24%	1%	9%	23%	45%	22%	1%	10%	22%	45%	22%	2%
Portugal	% over total	3%	18%	61%	11%	7%	4%	15%	63%	10%	7%	6%	15%	63%	13%	3%	6%	17%	63%	10%	4%	7%	16%	60%	11%	6%	7%	18%	58%	13%	4%	8%	18%	61%	13%	1%
Romania	% over total	12%	18%	45%	18%	8%	12%	20%	41%	16%	11%	11%	20%	44%	15%	10%	12%	23%	48%	14%	3%	13%	23%	45%	16%	4%	13%	23%	43%	19%	2%	14%	23%	47%	16%	1%
Slovakia	% over total	5%	20%	57%	10%	8%	5%	24%	51%	9%	12%	5%	25%	51%	9%	10%	6%	26%	50%	9%	10%	8%	28%	51%	7%	7%	8%	28%	51%	9%	4%	7%	30%	50%	9%	4%
Slovenia	% over total	6%	18%	63%	12%	2%	4%	20%	59%	14%	4%	6%	14%	63%	14%	2%	6%	14%	61%	14%	4%	6%	15%	60%	17%	2%	7%	15%	57%	17%	4%	4%	20%	60%	13%	2%
Spain	% over total	6%	26%	48%	14%	6%	6%	24%	54%	13%	3%	7%	24%	51%	14%	4%	7%	26%	53%	14%	2%	7%	28%	51%	13%	1%	7%	29%	49%	14%	1%	7%	29%	49%	14%	1%
Sweden	% over total	1%	7%	66%	4%	22%	1%	6%	67%	5%	21%	1%	6%	67%	4%	21%	1%	7%	67%	5%	21%	1%	6%	64%	5%	24%	1%	7%	65%	5%	23%	1%	7%	62%	4%	26%
United Kingdom	% over total	7%	26%	45%	15%	8%	7%	26%	52%	14%	2%	7%	26%	52%	14%	1%	8%	22%	55%	14%	1%	7%	23%	58%	12%	0%	7%	22%	58%	12%	1%	7%	21%	60%	12%	0%
EU27 + UK	% over total	6%	19%	55%	13%	7%	6%	19%	56%	13%	6%	6%	19%	57%	13%	5%	6%	19%	56%	13%	5%	7%	20%	55%	13%	5%	6%	20%	56%	13%	5%	6%	19%	56%	13%	5%

	EU27 + UK MEAN	DEV. ST
C	7%	0,47%
B	19%	0,77%
A1	56%	0,77%
A2	12%	0,78%
Zero	6%	1,30%

LEGEND	
C	Large (emissions > 500 kt CO2-eq)
B	Medium (50 < emissions < 500 kt CO2-eq)
A1	Mini (0 < emissions < 25 kt CO2-eq)
A2	Small (25 < emissions < 50 kt CO2-eq)
Zero	Zero (emissions = 0 kt CO2-eq) [EMISSION FROM BIOMASS]

- (yellow) values > μ + 15 * σ
- (grey) values < μ - 15 * σ
- (red) countries that deviate significantly from the EU27 + UK values

Annex VI - EED Final energy consumption

EU Countries	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Difference [%] 2012vs.2020
	Final energy consumption [Million Tonnes of Oil eq TOE]													
Austria	23,73	25,16	25,37	26,66	27,05	27,87	27,89	27,61	27,77	26,42	28,06	27,21	27,21	-7,75%
Belgium	37,72	38,61	36,39	37,66	37,83	36,6	36,7	35,56	37	34,82	37,72	35,02	35,07	-7,33%
Bulgaria	9,07	9,09	9,07	9,75	9,65	10,14	10,51	10,33	9,97	8,59	8,83	9,25	9,22	-6,72%
Croatia	6	6,3	6,38	6,82	7	7,24	7,26	7,29	7,4	7,18	7,21	6,96	6,66	5,11%
Cyprus	1,65	1,71	1,72	1,82	1,83	1,83	1,87	1,93	1,97	1,94	1,93	1,92	1,77	7,34%
Czechia	25,05	25,5	25	26,22	26,5	26,15	26,54	26,08	25,93	24,94	25,25	24,46	24,41	3,65%
Denmark	14,72	15,13	14,8	15,13	15,36	15,5	15,66	15,72	15,53	14,79	15,52	14,8	14,29	6,37%
Estonia	2,43	2,66	2,62	2,75	2,82	2,88	2,9	3,11	3,11	2,77	2,92	2,85	2,9	-3,45%
Finland	24,36	24,86	25,48	25,88	26,14	25,22	26,51	26,55	25,68	23,87	26,26	25,03	25	6,04%
France	155,42	161,11	156,86	158,88	160,86	160,15	157,75	153,84	155,85	149,53	153,96	147,65	152,06	-9,31%
Germany	220,15	223,81	220,21	224,48	222,91	219,73	225,39	213	221,77	208,31	223,08	211,74	215,81	-9,97%
Greece	18,75	19,36	19,71	20,76	20,53	21,02	21,62	22,08	21,42	20,56	19,02	18,9	17,03	8,04%
Hungary	16,15	16,94	17	17,7	17,58	18,74	18,46	17,44	17,44	17,07	17,45	17,49	16,47	10,50%
Ireland	10,81	11,28	11,32	11,67	11,96	12,65	13,31	13,34	13,36	11,93	12,01	10,95	10,67	9,65%
Italy	124,82	126,14	126,45	133,33	133,8	137,22	135,66	134,62	134,28	126,17	128,51	123,18	121,82	1,79%
Latvia	3,25	3,57	3,62	3,8	3,91	4,02	4,19	4,35	4,15	4,04	4,12	3,87	4,03	11,66%
Lithuania	3,77	3,92	4,09	4,21	4,4	4,67	4,93	5,21	5,13	4,64	4,81	4,78	5	-12,24%
Luxembourg	3,51	3,67	3,71	3,95	4,39	4,48	4,41	4,34	4,38	4,08	4,33	4,29	4,17	0,72%
Malta	0,45	0,4	0,37	0,4	0,45	0,46	0,47	0,48	0,5	0,45	0,5	0,49	1	17,65%
Netherlands	52,09	52,95	53,02	53,83	54,6	54,07	53,76	53,06	53,91	51,68	55,34	51,68	51,82	0,73%
Poland	55,06	55,46	54,9	56,54	58,09	58,49	61,21	61,61	62,4	61,52	66,28	64,67	64,43	11,13%
Portugal	17,96	18,2	18,68	18,63	18,94	19,01	18,78	18,91	18,4	18,19	18,1	17,31	16	8,55%
Romania	22,69	23,15	23,17	24,2	24,85	24,6	24,77	24,14	24,68	22,23	22,52	22,7	22,76	33,13%
Slovakia	10,96	11,48	11,62	11,21	11,06	11,56	11,37	11,2	11,45	10,63	11,54	10,77	10,34	-11,03%
Slovenia	4,45	4,6	4,58	4,71	4,82	4,9	4,95	4,89	5,27	4,84	5,04	5,02	4,9	4,08%
Spain	80,02	84,03	85,35	90,72	95,05	98,08	95,81	98,4	94,83	87,78	89,09	86,48	82,83	5,28%
Sweden	34,98	34,45	34,23	34,03	33,95	33,51	33,39	33,5	32,89	31,61	34,2	32,56	32,65	-7,20%
United Kingdom	153,26	154,24	150,07	151,83	153,28	152,97	150,89	148,73	148,29	138,01	143,11	132,16	135,76	-4,83%
EU27 + UK	1.133,27	1.157,79	1.145,79	1.177,57	1.189,61	1.193,77	1.196,95	1.177,35	1.184,78	1.118,6	1.166,71	1.114,21	1.115,71	-2,66%

LEGEND	
(yellow)	Data related to EU27 + UK
(red)	Target not reached
(green)	Virtuos countries

Final energy consumption [Million Tonnes of Oil eq TOE]

EU Countries	Linear dec/increasing factor	2013 Effective	2013 Target	2013 Difference [%]	2014 Effective	2014 Target	2014 Difference [%]	2015 Effective	2015 Target	2015 Difference [%]	2016 Effective	2016 Target	2016 Difference [%]	2017 Effective	2017 Target	2017 Difference [%]	2018 Effective	2018 Target	2018 Difference [%]	2019 Target	TARGET 2020
Austria	-0,97%	27,95	26,95	4%	26,82	26,69	0,51%	27,51	26,43	4,10%	28,12	26,17	7,45%	28,61	25,92	10,39%	27,91	25,67	8,75%	25,42	25,1
Belgium	-0,92%	36,57	34,75	5%	34,26	34,43	-0,50%	35,93	34,12	5,32%	36,43	33,80	7,77%	36,1	33,49	7,78%	36,33	33,19	9,47%	32,88	32,5
Bulgaria	-0,84%	8,78	9,14	-4%	8,99	9,07	-0,83%	9,49	8,99	5,57%	9,65	8,91	8,26%	9,89	8,84	11,89%	9,91	8,76	13,07%	8,69	8,6
Croatia	0,64%	6,57	6,70	-2%	6,24	6,75	-7,49%	6,59	6,79	-2,92%	6,64	6,83	-2,81%	6,92	6,88	0,65%	6,85	6,92	-1,00%	6,96	7,
Cyprus	0,92%	1,62	1,79	-9%	1,62	1,80	-10,13%	1,67	1,82	-8,20%	1,77	1,84	-3,59%	1,87	1,85	0,93%	1,86	1,87	-0,52%	1,89	1,9
Czechia	0,46%	24,21	24,52	-1%	23,58	24,63	-4,27%	24,2	24,75	-2,20%	24,82	24,86	-0,15%	25,5	24,97	2,12%	25,32	25,09	0,94%	25,20	25,3
Denmark	0,80%	14,12	14,40	-2%	13,66	14,52	-5,91%	14,21	14,63	-2,90%	14,63	14,75	-0,82%	14,84	14,87	-0,19%	14,96	14,99	-0,18%	15,11	15,2
Estonia	-0,43%	2,9	2,89	0%	2,83	2,88	-1,57%	2,79	2,86	-2,54%	2,84	2,85	-0,36%	2,87	2,84	1,13%	2,96	2,83	4,75%	2,81	2,8
Finland	0,75%	24,68	25,37	-3%	24,52	25,56	-4,07%	24,21	25,75	-6,00%	25,18	25,95	-2,96%	25,27	26,14	-3,34%	25,84	26,34	-1,90%	26,54	26,7
France	-1,16%	154,7	150,29	3%	144,25	148,54	-2,89%	147,43	146,81	0,42%	149,32	145,10	2,91%	148,47	143,41	3,53%	146,61	141,74	3,43%	140,09	137,9
Germany	-1,25%	221,01	213,12	4%	209,98	210,47	-0,23%	212,75	207,84	2,36%	216,87	205,25	5,66%	218,62	202,70	7,86%	215,37	200,17	7,59%	197,68	194,3
Greece	1,01%	15,34	17,20	-11%	15,58	17,37	-10,33%	16,56	17,55	-5,64%	16,76	17,73	-5,45%	16,75	17,90	-6,44%	15,95	18,08	-11,80%	18,27	18,4
Hungary	1,31%	16,58	16,69	-1%	16,22	16,91	-4,05%	17,4	17,13	1,59%	17,83	17,35	2,75%	18,52	17,58	5,35%	18,54	17,81	4,09%	18,04	18,2
Ireland	1,21%	10,79	10,80	0%	10,83	10,93	-0,91%	11,21	11,06	1,35%	11,6	11,19	3,62%	11,72	11,33	3,45%	12,27	11,47	7,01%	11,60	11,7
Italy	0,22%	118,55	122,09	-3%	113,31	122,37	-7,40%	116,22	122,64	-5,23%	115,92	122,91	-5,69%	115,19	123,19	-6,49%	116,47	123,46	-5,66%	123,74	124,
Latvia	1,46%	3,86	4,09	-6%	3,89	4,15	-6,23%	3,79	4,21	-9,95%	3,82	4,27	-10,54%	4,01	4,33	-7,44%	4,18	4,40	-4,90%	4,46	4,5
Lithuania	-1,53%	4,78	4,83	-1%	4,88	4,75	2,71%	4,86	4,68	3,88%	5,1	4,61	10,71%	5,34	4,54	17,72%	5,55	4,47	24,25%	4,40	4,3
Luxembourg	0,09%	4,12	4,17	-1%	4	4,18	-4,25%	3,99	4,18	-4,57%	4,04	4,19	-3,47%	4,18	4,19	-0,21%	4,35	4,19	3,76%	4,20	4,2
Malta	2,21%	0,53	0,52	2%	0,55	0,53	3,24%	0,58	0,54	6,52%	0,58	0,56	4,22%	0,62	0,57	9,00%	0,66	0,58	13,53%	0,59	0,6
Netherlands	0,09%	51,92	51,87	0%	47,61	51,92	-8,29%	49,11	51,96	-5,49%	49,78	52,01	-4,29%	50,3	52,06	-3,38%	50,27	52,11	-3,52%	52,15	52,2
Poland	1,39%	63,25	65,33	-3%	61,55	66,23	-7,07%	62,3	67,16	-7,23%	66,6	68,09	-2,19%	70,97	69,04	2,80%	71,93	70,00	2,76%	70,97	71,6
Portugal	1,07%	15,85	16,20	-2%	15,77	16,37	-3,69%	16,01	16,55	-3,26%	16,2	16,73	-3,15%	16,57	16,90	-1,98%	16,91	17,09	-1,03%	17,27	17,4
Romania	4,14%	21,8	23,70	-8%	21,69	24,68	-12,13%	21,85	25,71	-15,00%	22,24	26,77	-16,92%	23,21	27,88	-16,75%	23,53	29,03	-18,96%	30,24	30
Slovakia	-1,38%	10,59	10,20	4%	9,96	10,06	-0,96%	10,06	9,92	1,43%	10,4	9,78	6,32%	11,13	9,65	15,37%	11,11	9,51	16,78%	9,38	9,2
Slovenia	0,51%	4,8	4,93	-3%	4,59	4,95	-7,28%	4,69	4,98	-5,74%	4,88	5,00	-2,41%	4,95	5,03	-1,52%	4,98	5,05	-1,42%	5,08	5,1
Spain	0,66%	80,73	83,38	-3%	79,19	83,93	-5,64%	80,35	84,48	-4,89%	82,23	85,04	-3,30%	84,56	85,60	-1,21%	86,84	86,16	0,79%	86,73	87,2
Sweden	-0,90%	31,93	32,36	-1%	31,12	32,07	-2,95%	31,67	31,78	-0,34%	32,05	31,49	1,78%	32,31	31,21	3,53%	32	30,93	3,47%	30,65	30,3
United Kingdom	-0,60%	136,91	134,94	1%	130,12	134,12	-2,99%	132,66	133,31	-0,49%	133,72	132,51	0,91%	133,63	131,71	1,46%	134,67	130,91	2,87%	130,12	129,2
EU27 + UK	-0,33%	1.115,45	1112,00	0%	1.067,58	1108,29	-3,67%	1.090,09	1104,61	-1,31%	1.110,02	1100,93	0,83%	1.122,93	1097,26	2,34%	1.124,14	1093,61	2,79%	1089,97	1086

LEGEND	
(yellow)	Data related to EU27 + UK
(red)	Target not reached
(green)	Virtuos countries

Annex VII - EED Primary energy consumption

	Primary energy consumption [Million Tonnes of Oil eq TOE]													
EU Countries	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Difference [%] 2012vs.2020
Austria	27,5	29,1	29,3	30,9	31,4	32,7	32,6	32,2	32,5	30,6	32,9	32	31,6	-0,32%
Belgium	52,4	52,1	50,1	52,6	52,4	51,6	51,4	50,3	51,1	50,5	54,1	50,5	47,8	-8,58%
Bulgaria	17,7	18,6	18,5	18,7	18,2	19,2	19,9	19,5	19	16,9	17,4	18,6	17,8	-5,06%
Croatia	7,8	8,2	8,5	9	8,9	9,1	9,1	9,4	9,2	9	8,9	8,7	8,2	30,49%
Cyprus	2,3	2,4	2,4	2,6	2,4	2,5	2,6	2,7	2,9	2,8	2,7	2,7	2,5	-12,00%
Czechia	39,1	40,2	40,6	42,5	43,1	42,5	43,5	43,7	42,5	40,1	42,7	41	40,6	9,11%
Denmark	19,1	19,8	19,4	20,5	20	19,5	20,8	20,4	19,9	18,9	20	18,5	17,8	-1,69%
Estonia	4,6	4,8	4,6	5,1	5,1	5,1	4,9	5,5	5,4	4,7	5,6	5,6	5,4	20,37%
Finland	31,6	32,6	34,2	36,1	36,6	33,6	36,7	36	34,6	32,4	35,5	34,3	33	8,79%
France	239,8	248,7	248,9	255	259,3	260,9	256,2	252,7	255,4	246,3	254,5	249,2	249,2	-9,15%
Germany	317,1	327,1	319,4	321,9	323,7	321,6	332,8	315,8	320,8	299,9	315,2	297,8	301,1	-8,14%
Greece	27,1	28	28,5	29,1	29,5	30,2	30,1	30,2	30,4	29,3	27,1	26,6	26,4	-6,44%
Hungary	23,6	24,4	24,2	25	24,9	26,4	26	25,4	25,2	24	24,6	24,4	23,1	15,15%
Ireland	13,7	14,6	14,9	14,5	14,8	15	15,1	16	15,7	14,9	14,7	13,5	13,7	1,46%
Italy	166,1	165,4	166,7	175,8	177,7	180,8	179	178,7	176,1	164,1	167,3	162	156,6	0,89%
Latvia	3,8	4,1	4	4,3	4,4	4,5	4,7	4,8	4,6	4,4	4,6	4,3	4,4	22,73%
Lithuania	6,5	7,5	8,1	8,4	8,6	8,1	7,9	8,1	8,3	7,8	6,2	5,9	6	8,33%
Luxembourg	3,6	3,8	4	4,2	4,7	4,8	4,7	4,6	4,6	4,3	4,6	4,5	4,4	2,27%
Malta	0,8	0,9	0,8	0,9	0,9	0,9	0,9	1	1	0,9	0,9	0,9	1	-20,00%
Netherlands	66,9	69	69,1	70,5	71,4	70,1	69,5	69,4	69,9	67,6	71,7	67,1	66,8	-9,13%
Poland	84,9	86	85,1	87	87	88	92,4	91,9	93,1	89,5	96,6	96,6	93,1	3,54%
Portugal	23	23,3	24,4	23,6	24,2	24,9	24	23,9	23,6	23,6	22,6	22	21	7,14%
Romania	34,9	35,2	36,5	38,3	37,3	36	37,5	37,4	37,3	32,7	33	33,6	33,3	29,13%
Slovakia	16,4	17,2	17,3	17,3	16,9	17,4	17,2	16,4	17	15,5	16,7	16	15,6	5,13%
Slovenia	6,2	6,5	6,7	6,7	6,9	7	7	7	7,5	6,8	7	7,1	6,8	4,41%
Spain	115	118	121,8	126,6	133,4	136,6	136,7	139,4	134,4	123,4	123,3	123	123,4	0,00%
Sweden	46	48,5	49,1	48,5	50,5	49,3	48	47,7	47,5	43,3	48,6	47,6	47,6	-8,82%
United Kingdom	222	224	220	223,8	221,4	223,5	220,4	214,5	211,8	196	205,1	190,1	195,2	-9,02%
EU27 + UK	1.619,4	1.659,9	1.657,1	1.699,2	1.715,4	1.721,4	1.731,6	1.704,4	1.700,9	1.600,4	1.663,9	1.603,8	1.593,3	-6,92%

LEGEND	
(yellow)	Data related to EU27 + UK
(red)	Target not reached
(green)	Virtuos countries

EU Countries	Primary energy consumption [Million Tonnes of Oil eq TOE]																			
	Linear dec/increasing factor	2013			2014			2015			2016			2017			2018			2019	TARGET 2020
		Effective	Target	Difference [%]	Effective	Target	Difference [%]	Effective	Target	Difference [%]	Effective	Target	Difference [%]	Effective	Target	Difference [%]	Effective	Target	Difference [%]	Target	
Austria	-0,04%	32,1	31,59	2%	30,8	31,58	-2,45%	31,6	31,56	0,12%	31,9	31,55	1,11%	32,8	31,54	4,00%	31,8	31,53	0,87%	31,51	31,5
Belgium	-1,07%	49,3	47,29	4%	45,7	46,78	-2,31%	46,1	46,28	-0,39%	49,2	45,78	7,46%	49,1	45,29	8,41%	46,8	44,81	4,45%	44,33	43,7
Bulgaria	-0,63%	16,5	17,69	-7%	17,3	17,58	-1,57%	18	17,46	3,07%	17,7	17,35	1,99%	18,3	17,24	6,12%	18,4	17,14	7,38%	17,03	16,9
Croatia	3,81%	8	8,51	-6%	7,6	8,84	-14,00%	8	9,17	-12,79%	8,1	9,52	-14,95%	8,3	9,89	-16,04%	8,2	10,26	-20,10%	10,65	10,7
Cyprus	-1,50%	2,2	2,46	-11%	2,2	2,43	-9,30%	2,3	2,39	-3,73%	2,4	2,35	1,98%	2,5	2,32	7,85%	2,6	2,28	13,87%	2,25	2,2
Czechia	1,14%	40,9	41,06	0%	39,2	41,53	-5,61%	39,7	42,00	-5,48%	40	42,48	-5,84%	40,4	42,97	-5,97%	40,4	43,46	-7,03%	43,95	44,3
Denmark	-0,21%	17,8	17,76	0%	16,9	17,73	-4,65%	16,9	17,69	-4,45%	17,6	17,65	-0,29%	17,9	17,61	1,63%	18	17,58	2,41%	17,54	17,5
Estonia	2,55%	6	5,54	8%	5,7	5,68	0,38%	5,3	5,82	-8,98%	5,9	5,97	-1,20%	5,7	6,12	-6,91%	6,2	6,28	-1,26%	6,44	6,5
Finland	1,10%	32	33,36	-4%	32,7	33,73	-3,05%	31,2	34,10	-8,50%	32,4	34,47	-6,02%	32,1	34,85	-7,90%	33	35,24	-6,34%	35,62	35,9
France	-1,14%	250,4	246,35	2%	239,8	243,53	-1,53%	244,4	240,75	1,52%	240,1	237,99	0,88%	239,2	235,27	1,67%	238,9	232,58	2,72%	229,92	226,4
Germany	-1,02%	308,3	298,04	3%	293,6	295,01	-0,48%	295,9	292,01	1,33%	297,6	289,04	2,96%	298,1	286,10	4,20%	291,8	283,19	3,04%	280,31	276,6
Greece	-0,80%	23,3	26,19	-11%	23,1	25,98	-11,07%	23,2	25,77	-9,96%	22,9	25,56	-10,41%	23,1	25,35	-8,89%	22,4	25,15	-10,94%	24,95	24,7
Hungary	1,89%	22,4	23,54	-5%	22	23,98	-8,27%	23,3	24,44	-4,65%	23,7	24,90	-4,82%	24,5	25,37	-3,44%	24,5	25,85	-5,23%	26,34	26,6
Ireland	0,18%	13,1	13,73	-5%	13,2	13,75	-4,00%	13,9	13,78	0,91%	14,6	13,80	5,80%	14,4	13,83	4,16%	14,5	13,85	4,69%	13,88	13,9
Italy	0,11%	152,1	156,78	-3%	142,7	156,95	-9,08%	149,1	157,13	-5,11%	148	157,30	-5,91%	149	157,48	-5,38%	147,2	157,65	-6,63%	157,83	158,
Latvia	2,84%	4,4	4,53	-3%	4,4	4,65	-5,45%	4,3	4,79	-10,15%	4,3	4,92	-12,63%	4,5	5,06	-11,09%	4,7	5,21	-9,71%	5,35	5,4
Lithuania	1,04%	5,8	6,06	-4%	5,8	6,13	-5,32%	5,8	6,19	-6,29%	6	6,25	-4,06%	6,2	6,32	-1,88%	6,3	6,38	-1,33%	6,45	6,5
Luxembourg	0,28%	4,3	4,41	-3%	4,2	4,43	-5,09%	4,1	4,44	-7,61%	4,2	4,45	-5,62%	4,3	4,46	-3,65%	4,5	4,48	0,55%	4,49	4,5
Malta	-2,50%	0,9	0,98	-8%	0,9	0,95	-5,33%	0,8	0,93	-13,69%	0,7	0,90	-22,54%	0,8	0,88	-9,20%	0,8	0,86	-6,88%	0,84	0,8
Netherlands	-1,14%	66,2	66,04	0%	62,3	65,28	-4,57%	63,7	64,54	-1,30%	64,8	63,80	1,56%	65,1	63,07	3,21%	64,7	62,35	3,76%	61,64	60,7
Poland	0,44%	93,5	93,51	0%	89,5	93,93	-4,71%	90,1	94,34	-4,50%	94,8	94,76	0,04%	99,2	95,18	4,22%	101,1	95,60	5,75%	96,03	96,4
Portugal	0,89%	21	21,19	-1%	20,7	21,38	-3,17%	21,6	21,57	0,15%	21,8	21,76	0,18%	22,8	21,95	3,85%	22,6	22,15	2,03%	22,35	22,5
Romania	3,64%	30,4	34,51	-12%	30,1	35,77	-15,85%	30,7	37,07	-17,19%	30,6	38,42	-20,36%	32,4	39,82	-18,63%	32,5	41,27	-21,25%	42,77	43
Slovakia	0,64%	15,7	15,70	0%	14,8	15,80	-6,33%	15,2	15,90	-4,41%	15,4	16,00	-3,77%	16,2	16,11	0,58%	15,8	16,21	-2,53%	16,31	16,4
Slovenia	0,55%	6,6	6,84	-3%	6,4	6,88	-6,91%	6,3	6,91	-8,87%	6,5	6,95	-6,49%	6,7	6,99	-4,14%	6,7	7,03	-4,67%	7,07	7,1
Spain	0,00%	116,1	123,40	-6%	114,2	123,40	-7,46%	118,6	123,40	-3,89%	119,3	123,40	-3,32%	125,8	123,40	1,94%	124,6	123,40	0,97%	123,40	123,4
Sweden	-1,10%	46,4	47,08	-1%	46	46,56	-1,19%	44,3	46,04	-3,78%	45,4	45,53	-0,30%	46,5	45,03	3,26%	46,8	44,54	5,08%	44,04	43,4
United Kingdom	-1,13%	191,6	193,00	-1%	180,7	190,82	-5,31%	183,1	188,67	-2,95%	179	186,55	-4,05%	176,9	184,45	-4,09%	176,3	182,37	-3,33%	180,31	177,6
EU27 + UK	-0,87%	1.577,4	1579,51	0%	1.512,4	1565,84	-3,41%	1.537,6	1552,29	-0,95%	1.544,9	1538,86	0,39%	1.562,4	1525,55	2,42%	1.551,9	1512,34	2,62%	1499,26	1483

LEGEND	
(yellow)	Data related to EU27 + UK
(red)	Target not reached
(green)	Virtuos countries

Annex VIII - EED Energy Intensity

		Energy Intensity of GDP in chain linked volumes (2010) [Kilograms of Oil eq / thousand euro]																		
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
EU Countries	Austria	115,11	119,91	118,64	123,71	122,69	124,06	120,99	114,66	113,95	112,35	117,79	111,11	109,95	111,44	106,68	108,06	107,00	106,73	101,76
	Belgium	211,40	207,07	201,88	209,75	203,83	197,98	192,97	186,00	191,06	181,05	189,68	174,03	163,94	169,42	156,56	154,55	162,38	160,97	158,20
	Bulgaria	760,39	765,56	705,77	689,37	630,26	622,43	600,19	552,59	514,63	469,94	473,46	495,02	472,42	438,04	449,49	451,80	426,02	426,03	414,36
	Croatia	240,06	241,35	236,18	239,09	229,77	223,95	212,21	209,57	201,01	209,07	210,08	206,39	198,55	195,74	186,70	190,12	185,37	186,08	177,36
	Cyprus	187,14	181,70	172,83	181,39	158,15	166,56	164,98	162,18	163,24	161,02	151,73	149,33	145,40	138,79	143,56	142,50	144,44	142,25	140,37
	Czechia	360,00	358,92	357,87	360,73	352,64	327,77	313,70	296,43	283,36	279,59	290,96	274,52	274,73	277,68	260,94	248,74	240,49	238,69	232,55
	Denmark	92,33	93,23	90,62	95,31	89,74	85,59	88,98	86,57	84,46	82,94	86,81	79,79	75,99	75,89	71,41	69,86	69,59	68,57	67,51
	Estonia	456,03	447,71	403,33	413,07	397,10	357,14	323,43	336,61	343,95	350,04	395,89	366,91	358,55	392,69	356,70	326,84	349,09	319,12	331,01
	Finland	211,78	211,01	218,58	225,66	218,83	196,77	206,03	192,46	183,62	186,03	196,99	184,96	180,48	179,30	183,53	174,28	176,94	172,56	173,09
	France	146,92	148,56	147,21	149,56	147,92	146,06	140,56	136,01	136,23	134,84	136,32	131,02	130,59	130,32	124,06	124,71	121,18	118,49	116,05
	Germany	146,37	148,06	145,15	146,63	145,97	144,31	143,25	132,49	132,83	131,73	132,98	121,38	121,87	123,92	116,06	114,66	112,98	110,75	106,34
	Greece	165,88	163,19	157,57	152,92	147,96	147,65	141,22	137,14	138,10	137,75	137,39	147,47	155,00	142,16	139,34	140,02	137,59	141,72	136,31
	Hungary	312,79	307,55	293,48	287,88	275,56	285,08	271,06	264,61	257,80	262,78	268,65	258,59	249,45	236,24	225,81	230,04	228,50	228,60	217,60
	Ireland	114,62	114,78	110,00	102,38	98,11	94,85	90,88	89,29	92,33	92,80	90,62	82,93	83,72	79,22	73,32	61,68	62,57	56,94	53,19
	Italy	112,80	110,93	111,52	116,85	116,04	117,26	114,36	112,52	112,14	110,42	111,60	107,04	106,02	103,91	98,21	101,22	99,21	100,90	98,80
	Latvia	313,87	330,71	307,55	299,50	284,05	265,26	242,59	225,05	225,28	256,44	273,93	242,48	242,30	233,22	227,76	218,22	217,77	214,49	206,54
	Lithuania	406,58	435,88	436,82	411,95	391,92	345,51	317,61	308,53	300,54	322,18	258,30	252,58	244,96	222,87	214,35	215,69	217,79	218,65	214,39
	Luxembourg	118,76	122,17	122,68	127,22	136,36	134,87	126,15	114,21	115,80	114,03	115,64	110,92	108,66	101,91	95,18	90,30	86,64	87,88	88,73
	Malta	272,10	297,60	282,03	319,66	334,18	266,96	277,87	284,81	289,01	318,05	361,81	339,32	314,82	286,73	269,06	263,07	267,65	296,90	289,19
	Netherlands	163,75	165,54	166,52	169,68	170,04	166,40	161,46	155,77	150,52	150,91	156,47	147,09	147,00	143,77	135,13	132,83	132,16	129,72	124,75
	Poland	363,50	361,50	350,22	347,03	331,20	324,10	321,43	299,00	290,20	270,58	281,36	267,95	253,59	251,86	234,67	228,54	232,57	232,09	223,73
	Portugal	155,94	152,87	157,89	155,83	158,40	160,66	150,97	146,90	143,28	145,24	138,24	137,74	135,57	137,26	137,85	140,68	138,27	139,83	133,08
	Romania	443,33	424,04	415,55	423,08	377,55	354,67	340,29	315,29	287,35	266,72	279,26	279,54	268,02	236,06	226,53	219,83	209,16	205,92	197,48
	Slovakia	422,25	426,64	411,43	387,92	362,80	348,45	318,45	275,17	268,07	259,13	260,11	245,50	231,90	233,22	213,44	210,17	206,82	211,79	201,46
	Slovenia	231,80	235,73	231,08	227,07	224,25	221,63	210,21	197,34	202,13	196,79	198,95	197,32	195,42	192,77	180,83	175,31	177,46	174,92	168,79
	Spain	149,44	148,18	148,28	148,89	150,82	149,01	143,28	140,84	135,21	129,68	129,03	129,67	133,02	125,63	122,09	121,62	119,36	121,03	118,34
	Sweden	162,83	170,20	169,40	163,38	163,63	156,30	146,08	140,47	140,33	133,46	140,56	136,15	136,71	132,46	127,96	117,23	120,09	120,64	118,17
	United Kingdom	148,48	144,73	139,36	137,46	133,24	130,00	124,76	117,86	116,95	113,18	115,56	105,94	106,33	102,43	94,39	93,73	90,56	87,78	86,36
	EU 27 + UK	158,60	158,53	156,52	158,22	156,10	153,64	149,72	143,32	142,17	139,40	141,84	134,70	133,85	131,88	124,86	123,67	122,02	120,94	117,75

Annex IX - Share of energy from renewable sources

Overall share of energy from renewable sources [%]

EU COUNTRIES	2005 %	2006 %	2006 Δ 2006-2005	2007 %	2007 Δ 2007-2006	2008 %	2008 Δ 2008-2007	2009 %	2009 Δ 2009-2008	2010 %	2010 Δ 2010-2009	2011 %	2011 Δ 2011-2010
Austria	24,4%	26,3%	8,0%	28,2%	7,0%	28,9%	2,4%	31,0%	7,5%	31,2%	0,6%	31,6%	1,2%
Belgium	2,3%	2,6%	12,9%	3,1%	17,8%	3,6%	15,8%	4,7%	31,3%	5,6%	19,7%	6,3%	11,5%
Bulgaria	9,2%	9,4%	2,6%	9,1%	-3,4%	10,3%	13,7%	12,0%	16,0%	13,9%	16,0%	14,2%	1,6%
Croatia	23,7%	22,7%	-4,3%	22,2%	-2,2%	22,0%	-0,8%	23,6%	7,3%	25,1%	6,4%	25,4%	1,1%
Cyprus	3,1%	3,3%	4,2%	4,0%	22,7%	5,1%	28,2%	5,9%	15,4%	6,2%	4,2%	6,3%	1,4%
Czechia	7,1%	7,4%	3,5%	7,9%	7,2%	8,7%	9,9%	10,0%	15,0%	10,5%	5,4%	10,9%	4,1%
Denmark	16,0%	16,3%	2,4%	17,7%	8,7%	18,5%	4,5%	20,0%	7,6%	21,9%	9,7%	23,4%	6,8%
Estonia	17,4%	16,0%	-8,4%	17,0%	6,8%	18,6%	9,4%	22,9%	23,0%	24,6%	7,2%	25,3%	3,1%
Finland	28,8%	30,1%	4,3%	29,6%	-1,6%	31,4%	6,0%	31,3%	-0,1%	32,4%	3,5%	32,8%	1,1%
France	9,6%	9,3%	-2,7%	10,2%	9,7%	11,2%	9,2%	12,2%	9,2%	12,7%	3,7%	11,0%	-13,1%
Germany	7,2%	8,5%	18,1%	10,1%	18,6%	10,1%	0,3%	10,9%	7,7%	11,7%	7,5%	12,5%	6,7%
Greece	7,3%	7,5%	2,5%	8,2%	10,6%	8,2%	-0,8%	8,7%	6,7%	10,1%	15,4%	11,2%	10,7%
Hungary	6,9%	7,4%	7,2%	8,6%	15,4%	8,6%	-0,1%	11,7%	36,3%	12,7%	9,2%	14,0%	9,7%
Ireland	2,8%	3,0%	7,7%	3,5%	14,0%	3,9%	13,7%	5,2%	31,8%	5,7%	10,2%	6,6%	16,4%
Italy	7,5%	8,3%	10,3%	9,8%	17,8%	11,5%	17,2%	12,8%	11,2%	13,0%	1,9%	12,9%	-1,1%
Latvia	32,3%	31,1%	-3,5%	29,6%	-4,9%	29,8%	0,7%	34,3%	15,1%	30,4%	-11,5%	33,5%	10,2%
Lithuania	16,8%	16,9%	0,7%	16,5%	-2,4%	17,8%	8,1%	19,8%	11,1%	19,6%	-0,8%	19,9%	1,6%
Luxembourg	1,4%	1,5%	4,8%	2,7%	85,5%	2,8%	3,2%	2,9%	4,4%	2,9%	-2,6%	2,9%	0,3%
Malta	0,1%	0,1%	21,0%	0,2%	18,4%	0,2%	10,2%	0,2%	13,3%	1,0%	342,7%	1,8%	89,0%
Netherlands	2,5%	2,8%	12,1%	3,3%	18,7%	3,6%	9,0%	4,3%	18,6%	3,9%	-8,2%	4,5%	15,5%
Poland	6,9%	6,9%	-0,2%	6,9%	0,6%	7,7%	11,3%	8,7%	12,3%	9,3%	6,8%	10,3%	11,3%
Portugal	19,5%	20,8%	6,5%	21,9%	5,5%	22,9%	4,6%	24,4%	6,4%	24,2%	-1,0%	24,6%	1,9%
Romania	17,6%	17,1%	-2,7%	18,2%	6,4%	20,2%	11,0%	22,2%	9,7%	22,8%	3,1%	21,2%	-7,2%
Slovak Republic	6,4%	6,6%	3,5%	7,8%	17,9%	7,7%	-0,5%	9,4%	21,3%	9,1%	-2,9%	10,3%	13,7%
Slovenia	16,0%	15,6%	-2,6%	15,6%	0,1%	15,0%	-3,9%	20,1%	34,4%	20,4%	1,4%	20,3%	-0,8%
Spain	8,4%	9,1%	8,4%	9,7%	5,6%	10,7%	11,2%	13,0%	20,7%	13,8%	6,5%	13,2%	-4,2%
Sweden	40,7%	42,4%	4,2%	43,9%	3,5%	44,7%	1,7%	47,9%	7,2%	47,0%	-1,9%	48,2%	2,7%
United Kingdom	1,1%	1,3%	19,8%	1,6%	19,9%	2,7%	67,9%	3,3%	24,1%	3,8%	13,2%	4,3%	14,2%
EU 27 + UK	9,1%	9,7%	6,4%	10,6%	9,6%	11,4%	7,1%	12,6%	11,0%	13,2%	4,2%	13,4%	1,9%

EU COUNTRIES	2012 %	2012 Δ 2012-2011	2013 %	2013 Δ 2013-2012	2014 %	2014 Δ 2014-2013	2015 %	2015 Δ 2015-2014	2016 %	2016 Δ 2016-2015	2017 %	2017 Δ 2017-2016	2018 %	2018 Δ 2018-2017	% MISSING FOR THE TARGET	2020 TARGET
Austria	32,7%	3,5%	32,8%	0,3%	33,7%	2,7%	33,5%	-0,3%	33,4%	-0,5%	33,1%	-0,7%	33,4%	0,9%	0,6%	34%
Belgium	7,2%	14,2%	7,5%	4,7%	8,0%	6,9%	8,0%	-0,4%	8,7%	8,9%	9,1%	4,0%	9,4%	4,0%	3,6%	13%
Bulgaria	15,8%	11,9%	18,9%	19,3%	18,0%	-4,5%	18,3%	1,2%	18,8%	2,7%	18,7%	-0,3%	20,5%	9,8%	-4,5%	16%
Croatia	26,8%	5,4%	28,0%	4,8%	27,8%	-0,8%	29,0%	4,1%	28,3%	-2,4%	27,3%	-3,5%	28,0%	2,7%	-8,0%	20%
Cyprus	7,1%	14,0%	8,5%	18,5%	9,2%	8,5%	9,9%	8,3%	9,9%	-0,7%	10,5%	6,4%	13,9%	32,3%	-0,9%	13%
Czechia	12,8%	17,1%	13,9%	8,7%	15,1%	8,2%	15,1%	0,0%	14,9%	-0,9%	14,8%	-0,9%	15,1%	2,3%	-2,1%	13%
Denmark	25,5%	8,9%	27,2%	6,7%	29,3%	7,9%	30,8%	5,2%	31,8%	3,2%	34,7%	9,1%	35,7%	2,8%	-5,7%	30%
Estonia	25,5%	0,7%	25,3%	-0,8%	26,1%	3,2%	28,2%	8,0%	28,7%	1,6%	29,1%	1,5%	30,0%	3,0%	-5,0%	25%
Finland	34,4%	5,0%	36,7%	6,7%	38,8%	5,6%	39,3%	1,4%	39,0%	-0,8%	40,9%	4,9%	41,2%	0,6%	-3,2%	38%
France	13,4%	22,0%	14,0%	4,5%	14,6%	3,8%	15,0%	3,0%	15,7%	4,4%	16,0%	2,1%	16,6%	3,6%	6,4%	23%
Germany	13,6%	8,7%	13,8%	1,6%	14,4%	4,5%	14,9%	3,6%	14,9%	-0,1%	15,5%	3,9%	16,5%	6,5%	1,5%	18%
Greece	13,7%	23,2%	15,3%	11,5%	15,7%	2,3%	15,7%	0,0%	15,4%	-1,9%	17,0%	10,1%	18,0%	6,2%	0,0%	18%
Hungary	15,5%	11,2%	16,2%	4,3%	14,6%	-9,8%	14,5%	-0,8%	14,3%	-1,2%	13,5%	-5,6%	12,5%	-7,6%	0,5%	13%
Ireland	7,1%	6,1%	7,6%	8,0%	8,6%	12,9%	9,1%	5,9%	9,3%	1,6%	10,6%	14,4%	11,1%	4,5%	4,9%	16%
Italy	15,4%	19,9%	16,7%	8,4%	17,1%	2,0%	17,5%	2,6%	17,4%	-0,6%	18,3%	4,9%	17,8%	-2,7%	-0,8%	17%
Latvia	35,7%	6,7%	37,0%	3,7%	38,6%	4,3%	37,5%	-2,8%	37,1%	-1,1%	39,0%	5,1%	40,3%	3,3%	-0,3%	40%
Lithuania	21,4%	7,5%	22,7%	5,8%	23,6%	4,0%	25,8%	9,1%	25,6%	-0,5%	26,0%	1,7%	24,4%	-6,1%	-1,4%	23%
Luxembourg	3,1%	9,3%	3,5%	12,4%	4,5%	27,8%	5,0%	11,9%	5,4%	7,7%	6,3%	15,6%	9,1%	44,1%	1,9%	11%
Malta	2,9%	54,7%	3,8%	31,4%	4,7%	26,2%	5,1%	7,9%	6,2%	21,3%	7,3%	17,1%	8,0%	9,7%	2,0%	10%
Netherlands	4,7%	3,0%	4,7%	0,7%	5,4%	15,4%	5,7%	4,5%	5,8%	3,0%	6,5%	10,9%	7,4%	14,3%	6,6%	14%
Poland	10,9%	5,9%	11,4%	4,3%	11,5%	1,1%	11,7%	2,2%	11,3%	-4,1%	11,0%	-2,7%	11,3%	2,9%	3,7%	15%
Portugal	24,6%	-0,2%	25,7%	4,6%	29,5%	14,8%	30,5%	3,4%	30,9%	1,1%	30,6%	-0,8%	30,3%	-0,9%	0,7%	31%
Romania	22,8%	7,7%	23,9%	4,6%	24,8%	4,0%	24,8%	-0,2%	25,0%	1,0%	24,5%	-2,3%	23,9%	-2,4%	0,1%	24%
Slovak Republic	10,5%	1,0%	10,1%	-3,1%	11,7%	15,6%	12,9%	10,0%	12,0%	-6,6%	11,5%	-4,7%	11,9%	3,8%	2,1%	14%
Slovenia	20,8%	2,8%	22,4%	7,6%	21,5%	-3,9%	21,9%	1,6%	21,3%	-2,7%	21,1%	-1,1%	21,1%	0,4%	3,9%	25%
Spain	14,3%	8,0%	15,3%	7,2%	16,1%	5,3%	16,2%	0,6%	17,4%	7,4%	17,6%	0,8%	17,5%	-0,6%	2,5%	20%
Sweden	50,2%	4,1%	50,8%	1,1%	51,9%	2,1%	53,0%	2,2%	53,4%	0,7%	54,2%	1,6%	54,6%	0,8%	-5,6%	49%
United Kingdom	4,4%	2,1%	5,5%	24,7%	6,7%	22,5%	8,3%	23,7%	9,0%	7,7%	9,7%	8,4%	11,0%	13,2%	4,0%	15%
EU 27 + UK	14,7%	9,5%	15,4%	4,7%	16,2%	5,5%	16,7%	3,2%	17,0%	1,6%	17,5%	2,8%	18,0%	2,9%	2,0%	20%

LEGEND	
(yellow)	Data related to EU27 + UK
(red)	Degrowth between two consecutive years
(grey)	Target already reached in 2018
(light pink)	Less than 1 point % distance from target
(green)	Virtuos countries

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