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The Future of Climate and Energy in the EU

Exploring the EU strategies to combat climate change while maintaining a safe and sustainable energy producing sector

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Abstract

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This document treats climate change as a negative externality originating from greenhouse gas emissions produced by mankind. The focus of this article lies on emissions originating in the energy sector and the EU's strategies to combat climate change. Energy security is explored as a whole and then centered on the issues the EU faces with regards to energy security. The strategies which the EU has developed to combat climate change while maintaining a competitive and secure energy sector are extremely important as the EU is highly dependent on imports of the resources for energy. The EU will be increasingly dependent on the imports of gas and there is only one affordable supplier which already supplies the largest shares of any mainstream fossil fuel imports into the EU. Increasing dependency on this key stakeholder brings risks and these must be carefully considered when high ranking officials make decisions. However, with the amount of nuclear energy supply being reduced, the transition into an emission free energy sector is not an easy shift and this will take time and therefore temporary middle checkpoints are necessary to support the shift towards climate neutrality.

Keywords: European Union, Climate Change, Energy Security

Contents

Glossary

CO_2	Carbon dioxide.
ETS	Emission Trading Scheme.
EU	European Union.
UK	United Kingdom.
US	United States.

1 Introduction

1.1 Climate change

The Cenozoic is the current era of planet Earth in geological terms. This is the time of the current ice age cycles we live in. Climate change was discovered already over 150 years ago. At first it was deemed positive for humanity as it would postpone a future ice age. (Yergin, 2012) By now it seems clear that climate has become more of a danger than a comfort to humanity. Currently, humankind is well on its way to postpone future ice ages as well as changing the climate as a whole. (NASA, 2020)

The externality of climate change as a result from greenhouse gas emissions is incredibly complex. The area for which the externality applies is the whole Earth and its atmosphere while the production or consumption where the emissions originate is possible to be located down to certain areas, even as precise as the exhaust of one's car. The point is that the origin of these emissions is not equally spread over the area where the externalities' effects will be noticed. This has led to a change over the past decades, as climate change has and currently is becoming a more and more fiscal issue. The costs of not acting on it immediately are increasing for the time action is delayed or not taken. The externality has reached a status that requires governments' intervention before its consequences reach extremes.

In this document we shall approach climate change from an economic perspective, with a focus on the emissions causing climate change in the EU. The focus of this document is on greenhouse gas emissions as a negative externality from power generation. Whenever emissions are mentioned in this document, greenhouse gas emissions are meant, more specifically, units of CO2 equivalents.

The energy sector is the biggest emitter of greenhouse gas emissions in the European Union. Since 1990, the base year of the EU's and other countries' records, emissions have gradually and proportionally decreased in most sectors. (Statista, 2021) The energy sector has been able to reduce its emissions by roughly 30 percent since 1990. However, this remains by far the sector with most emissions. In 2018 this sector emitted nearly 34 percent more emissions than the second most greenhouse gas emitting sector. (European Environment Agency, 2019)

1.2 Energy sector

The industrial civilization of today has evolved over two centuries. Reducing the effects of climate change requires a change towards carbon-neutrality. This becomes particularly hard for the energy sector as since 1882 until late last century, over 90 percent of European energy has been and is generated by the combustion of hydrocarbons. (Heidorn, et al., 2019)

The status of EU energy production in 2019 is that still over 70 percent originated from the combustion of hydrocarbons. (Eurostat, 2021) The energy sector will have to undergo rapid transformation to clear out the gigantic amounts of emissions it produces as the EU is moving towards a climate-neutral economy. Furthermore, the EU has committed to reduce its emissions by at least 55 percent compared to 1990 as part of the European Green Deal. (European Commission, 2020)

Because of the growing population, simply generating less energy is not a viable option. Energy is needed for the fundamentals of human infrastructure, to keep the society running. Therefore, reaching the goal of lowering the emissions requires a change at the core of how energy is produced. At the same time, it is important to not depend on a single source of energy. The 1973 oil crisis is still regularly mentioned while this is nearly 50 years ago. The Arab oil producers except for Iraq decided to place an embargo on oil exports to the US. At this point the country’s leaders feared a coming lack of oil. This fear was not well grounded according to Adelman (Adelman, 1997). The oil produced and exported by other countries in Central and South America would quickly increase on top of the national production which would already be almost able to cover the total need of the US. As a result of this fear, too extreme measures were implemented within the US.

The effects of these measures were damaging for the US. The country was highly dependent on oil with no good alternative sources for power which increased the fear of a failing supply. This strong dependency on a single power source caused the oil markets to influence the society on a bigger scale and send shockwaves through the global economy. (Yergin, 2012) The price of oil skyrocketed, the result was that the US economy shrunk by about 2.5 percent while the unemployment rates went up as well did inflation. A result was a two-year long recession. (Verrastro, 2013)

As mentioned, the energy producing sector is highly dependent on the combustion of fossil fuels which makes it accountable for a significant part of the global emissions. However, energy is a part of daily life, and if it lacks presence even for small moments, whole systems collapse. This brings together two modern world problems that are of rising significance and need to be researched. Therefore, we have stated the following preliminary thesis issue: Making sense of the EU strategies to combat climate change while maintaining a safe and sustainable energy producing sector.

This topic is incredibly important as it affects all people that live on Earth and everyone contributes to greenhouse gas emissions, businesses as well as people. An enormous market failure is created as an externality or by-product of basically everything that is produced, sold, or serviced. The world suffers from negative externalities of energy production.

1.3 EU Strategy

The EU strategy regarding the combination of climate change and energy consists of three major publications: The 2020 climate & energy package (European Commission, 2020), the 2030 climate & energy framework

(European Commission, 2020), and the 2050 long-term strategy (European Commission, 2021). In these publications, the key climate and energy targets are defined. The targets have been established to direct the EU towards a competitive and climate-neutral economy by 2050. These publications can be seen as a roadmap for EU policies to reach the set goals.

The main goal of the EU is to commit to the Paris Agreement and prevent global warming to reach 2 degrees Celsius by 2050. The EU is aiming to keep it under 1.5 degrees Celsius. The other goal is to become the first climate-neutral continent by 2050. The EU has published packages / frameworks / strategies by which we are defining the EU Strategy in chapter 3.

1.4 The three pillars of EU Energy policy

The first pillar of EU energy policy, which the first energy policy was based on, is the security of supply. The 1973 oil crisis brought to light just how important oil was as a source of energy for countries all around the world. It made clear that oil was too heavily depended on by the developed countries. The global economy experienced an ‘oil shock’ and tumbled into a deep recession. After the 1973 oil crisis, in 1974 at the Copenhagen summit a supranational policy was agreed upon by member states to create greater cooperation and prosperity (M. Kanellakis, 2013). Throughout the decades, energy security has continued to be a subject of utmost importance. It was the main issue of the Single European Act (1986), The Maastricht Treaty (1992), and the Amsterdam Treaty (1997). These treaties were all focused toward broadening of energy supply sources, even without climate change, market deregulation, and environmental protection as subjects of European legislation.

The second pillar of EU energy policy is sustainable development, which includes decarbonization of energy supply. Sustainable development is the most recently added one out of all three. According to Sencar et al., it is also the most important pillar, particularly by the recent policy document Energy Roadmap 2050 (Sencar, et al., 2014). This is supported by how the EU presents its energy system's future as shown in the Figure 1 below. As the EU states in its Energy Roadmap 2050, *"The energy sector produces the lion's share of man-made greenhouse gas emissions. Therefore, reducing greenhouse gas emissions by 2050 by over 80% will put particular pressure on energy systems."* This can be directly interpreted as demonstrating that sustainable development will have to improve rapidly and the energy sector must develop towards an almost carbon free future of energy supply.

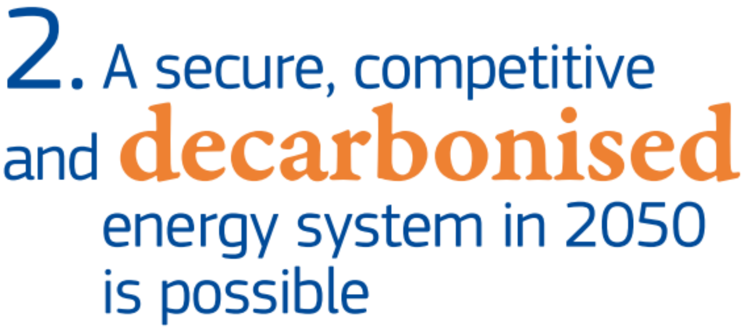

Figure 1, Chapter heading from EU Energy Roadmap 2050

The third pillar of EU energy policy is competitiveness. It is discussed by Sencar et al. as market development in the energy market. As also stated by Kanellakis, the aim of the EU energy policy is to achieve greater cooperation and prosperity. A major requirement for the third pillar was to achieve a network that connects all national and regional energy networks to a greater European energy network (M. Kanellakis, 2013). This would make it possible for all European customers to join one single energy market.

The internal energy market aims to create a better cooperation and security of supply. The basic idea of the internal energy market would be a single coherent market within the EU as described above. This would enable all current energy producers to deliver into one network. This would be much more efficient, and thus more competitive, than having multiple separate regional networks. It would reduce the capacity margins as all capacity margins of all existing regional networks would be combined into one larger one. Furthermore, this would enable all consumers to choose freely where they purchase their electricity. Suppliers would also be competing across the whole of the European Union, which would create a greater competitiveness within Europe, and so reduce the consumer price. (Helm, 2014)

1.5 What happens where?

In the next chapter, energy security is explained, along with how this is set up and maintained within and by the EU. As explained, dependency on a single source is not a safe energy system, and the EU has tried to address this. Chapter Three focuses on EU strategies regarding climate change and energy supply. This includes the development of renewable energy sources as well as increasing the efficiency of energy regeneration from gaseous hydrocarbon and reducing solid hydrocarbons as a resource for energy. The fourth chapter takes a closer look at the statistical data to review the EU's current consumption and outlooks of the forecasts until 2050. Chapter Five introduces theories advanced by various experts, thoroughly investigates these and compares them against each other. This combined with information from previous chapters is built into a more financial treatment of the subject. This combined with all previous mentioned elements comes together in the conclusion in Chapter Six.

2 EU Energy Security

2.1 The energy sector

An energy sector consists of all the organisations which are involved in the production of energy. The most central part of these are the energy companies related to the production of electricity. Other less obvious parts are for example, the resource extraction companies which extract the resources used to generate electricity from the nature, companies which refine oil into fuel for industry or transport or the pipeline companies that make sure oil and gas are delivered from the extraction to the refining and eventually to the place where it is consumed. Since the beginning of the industrial revolution, the energy sector has been essential in driving industrial growth. However, this has come at a cost for the natural environment, and this cost is still increasing as we are about to find out.

The latest confirmed net amount of electricity generated per year in the EU is from 2019 and stands at 2 724 705 Gigawatt hours. (Eurostat, 2021) This amount was generated for 513.5 million people. The amount of electricity needed will increase over the years as the amount of people increases, the amount of people that gain access to electrical equipment such as air conditioners and refrigerators increases, and as the developed world switches to electricity as a fuel instead of petrol and diesel to power their cars.

In the EU, the most important increase in energy will be the large part of industry and transport which is starting to use electricity instead of combustibles as fuel. As a result, electricity generation will have to substantially increase. On top of that, renewable energy sources are very intermittent. An energy system depending completely on renewables such as solar and wind power would lead to overproduction during daytime or in windy weather, and underproducing at night or in still weather. Batteries could theoretically provide a solution to this. However, batteries are currently not a viable option to store the energy on the scale that is needed in wintertime when production from wind and solar does not match the demand. In 2019 in the EU 2.7 million Gigawatt hours of electricity were generated, roughly 7.5 million MWh per day. The largest energy storage facility in the EU, in Schleswig-Holstein, Germany, has storage capabilities of 50 MWh. (en:former, 2019) This would mean that if there is a tough winter day without wind and sun, around 150 thousand of these batteries would need to be fully charged to cover the needs of the EU.

Another solution to the problem of intermittency and under generation by renewables would be to have energy generation plants which use conventional resources such as gas and nuclear to make up for the lack of production by renewables at certain times. Natural gas could be very well used for energy generation in highly efficient energy plants when renewables are producing low output. This should be offset by carbon capture for the already highly filtered emissions from burning the gas. Nuclear energy should also be considered as a standard source for energy production. This conventional method of energy generation has almost no emissions compared to other conventional sources of energy generation and has a significant output for the amount of resources and space needed compared to solar and wind power.

2.2 Energy security

Energy security is defined by the International Energy Agency as “the uninterrupted availability of energy sources at an affordable price.” (International Energy Agency, 2021) This means that if anyone in their home plugs in a lamp and flicks the switch, the lamp goes on and the monthly bill for the electricity stays affordable even for low-income households. Relying mainly on one source of energy has been shown in the past to be a weak spot for large areas of the whole world. For example, the October war and the oil “embargo” in 1973 resulted in a worldwide energy crisis. (Rapid Transition Alliance, 2019)

The October war, also known as the Yom Kippur War, was fought in the Middle East, between Israel and a coalition of Arab states. This caused a worldwide shock as the oil producing countries in the region decided to raise prices by 70% and drastically reduce production of oil. This did not immediately lead to a worldwide shortage as there were many other source areas for oil, this just happened to be the cheapest and most depended on source. One of the reasons for the increase of the price was that exports of oil to countries which were backing Israel in the war were stopped by the Arab oil producing countries, except for Iraq, for two months. After this event, the fear for a lack of cheap oil made the importance of energy security understood worldwide. (Adelman, 1997) And diversification of energy sources was sought after as well as reducing dependency on imports of energy sources. This is a similar theory as when investing in stocks, a more diverse portfolio is safer. Or as the saying goes: “do not put all your eggs in the same basket”.

More recent wars in the Middle East such as also the Iraqi Kuwait war with US intervention in 1991 very often are accompanied by worldwide fluctuations in oil supply and therefore prices. Other recent and more common incidents with energy security can be divided into two categories, generation failures and network failures. A generation failure occurs when the electricity generation cannot meet the demand. The so-called pull is greater than the push, if this happens, the electricity network, also called a grid, shuts down which results in a power outage in the area which is covered by the collapsing grid. Network failures occur when a part of the network breaks down and the electricity cannot be delivered to the area where it needs to be distributed to. For example, storms can break power poles and cables can break. In Finland for example, during storms in remote areas trees can fall over and break above-ground power lines and disrupt the power distribution. Areas can get separated from the production network and outages occur. (Bloom Energy, 2021)

Furthermore, if the energy supply drops completely, a country’s defenses will nearly be non-existent, and the population will not be able to defend themselves against invading forces. With no electricity, there is no warmth at night or in winter, no ways to heat or prepare food, and no public services, which include for example, running water, hospitals, communication services, police, and the fire department. This is one reason why all the EU member states are obliged to keep emergency oil stocks on top of their commercial oil stocks. (Eurostat, 2021) Germany for example, has nearly twice the EU daily consumption of oil stocked up to use in case of an emergency. (Statista, 2021) The necessary emergency generators are also installed at key locations to provide a backup power supply in case of an immediate disruption in energy supply. A more modern example of this are the emergency power generators at datacenters. At the moment they already have batteries installed to cover power supply for the time that the generators take to power up so that there is not a second without power as that could be disrupting the current digital environment which is so heavily depended on. (Koronen, et al., 2020)

2.3 EU energy security

As becomes clear, energy security provides the basis for life. It is hard to grasp just how important electricity is for most people in the EU. Since 1990, except for Romania in 2016, 100 % of the population in the EU have had access to electricity. (The World Bank Group, 2021) In sub-Saharan Africa there are hundreds of thousands that do not have access to electricity but use open fire to cook and candlelight at night. This might sound idyllic, but the truth is that the services and business are not able to exist the same way as it is known in the EU. This shows the importance of energy security. (Gates, 2021)

Now, energy production in the EU is almost a quarter dependent on gas. Therefore, the security of gas supplies is extremely important to the EU as it imports almost all of it as well. According to the EU Reference Scenario 2016, the dependency on gas is not likely to decrease any time before 2050. More likely, the usage of gas will steadily increase until at least 2045. (European Commission, 2016: 64) As discussed in the last chapter it is certainly not a good choice to depend too much on one single source of energy. Therefore, the EU has a large part of its energy security focused on how this is organized. (European Commission, 2021) This has been outlined in the EU framework for security of gas supply. This is a regulation built from a set of documents whose goal is for the EU to be prepared in case of emergencies related to gas supply disruptions.

A key part of the EU energy security is the diversification of supply routes and suppliers. (European Commission, 2020) As usual, businesses as well as supranational organizations try to get the best value for money. In terms of gas that would be quantity. However, there is usually only one supplier that can deliver at the lowest price. When dependent solely on one supplier, there is the single sourcing risk and just as regular businesses must choose their strategy to reduce the risk by choosing multiple suppliers, the EU must increase energy security by choosing multiple suppliers of gas. Another part is transmission of energy. Currently imported energy sources are brought in by boat, train, or through a pipeline. The EU also supports projects that enable the EU to import gas from new countries by building pipelines to reduce the dependence on one major supplier, Russia. More on this subject in chapter 4.2. (European Commission, 2020)

2.4 Nord Stream II

Gas is a commonly fed into Europe through pipelines from the east; the biggest existing pipeline flows from Russia, through Ukraine, into the EU. The second line from Russia goes through Belarus into the EU. There are two more pipelines from Russia, through Turkey into the EU. (Dupont & Oberthur, 2012) and a last route, a lot bigger than the others, that bypasses any third countries and flows from Russia, through the Gulf of Finland, into the Baltic Sea all the way to Germany. This pipeline is called Nord Steam 1. A current project about to be finished and taken into use is Nord Stream II.

Nord Stream II is a project for a gas transporting pipeline from Russia to Germany through the Baltic Sea. At the time of writing it is almost completed. This is to increase gas flow from Russia to EU. While the EU is supposed to reduce emissions and carbon fossil fuel usage (especially coal), the EU plans to increase gas imports so this project fits very well with its ambitions. However, when approached from a security perspective it is an addition to the supply from the already biggest supplier of gas. The addition of the northern route of gas supply should also improve the security as the pipeline does not cross any countries outside the EU which could influence the supply to the EU through political actions, such as the first time in 2006 when Russia and Ukraine were in a dispute over gas prices. (Reuters, 2009) Eventually Russia’s Gazprom, the supplier of gas, shut off all gas supplies to Ukraine, and thus also all gas supplies to EU which had to go through Ukraine. This has happened several more times in the last two decades. These events have directly led to a threat to EU energy security.

3 EU Strategies

3.1 The 2020 climate and energy package

The 2020 climate and energy package are based on the 20-20-20 aims set for 2020. The main goal is to reduce 20 percent of greenhouse gas emissions compared to 1990 emission levels. The other 20's stand for a 20 percent share for renewables in the energy mix and an aim to improve the energy efficiency by 20 percent. All these needed to be achieved by 2020 across all sectors and the energy sector is one of them. One of the EU's key tools for reducing emissions is the Emissions Trading Scheme (ETS). (European Commission, 2021) This is applied to the energy producing sector and therefore, we will focus on this tool in this document.

The second aim of 20 percent share for renewables was laid out in the Renewable Energy Directive in 2009. This was divided over all member countries to each have an aimed increase as some countries already had over 20% share of their energy mix from renewables. For example, Belgium had only 2.2 percent of renewable energy sources in their energy mix in 2005 and had to increase to 13% by 2020. Whereas Portugal was already at 20,5 percent and still had to increase to 31 percent so that every country in the EU contributes. (The European Parliament and the Council, 2009: 31)

The third target is regarding energy efficiency. As can be seen, these targets share a mutual interest. Improving the energy efficiency by 20 percent again requires input from all member states. On top of that efficiency will reduce the fossil fuels needed for the energy and thus less emissions. This will also create a benefit to the EU economy as efficiency in energy supply lowers the amount of resources needed. In other terms, this decreases the cost of raw materials which will increase the profitability.

3.2 2030 climate & energy framework

Initially the targets of the 2030 climate & energy framework set to cut at least 40 percent of greenhouse gas emissions from 1990 levels, at least 32 percent share for renewable energy, and at least 32,5 percent improvement in energy efficiency. (European Commission, 2020) In September 2020, the Commission proposed to raise the reduction target to 55% compared to 1990, to strengthen the emission reduction targets for each member state. For example Belgium now must reduce 47 percent of its emissions instead of an earlier estimated 35 percent compared to 2005 emission levels, while Portugal now needs to reduce 28.7 percent instead of 17 percent compared to 2005 emission levels. (The European Parliament And The Council, 2021) These plans have been implemented in June 2021 and include a raise of renewable share to 40 percent by 2030 and increased energy efficiency targets separately for each member state between 36 and 39 percent. The framework also included a revision of the ETS. This framework includes EU-wide targets and objectives to direct the EU towards climate-neutrality by 2050 and commit to the Paris Agreement.

3.3 2050 long-term strategy

The EU's goal is to be the first climate neutral continent by 2050 to better frame the efforts towards the goal of the Paris Agreement, which invites countries to formulate and submit a long-term strategy. This section discusses the strategy submitted by the EU. The transition to climate neutrality will bring significant opportunities such as potential for economic growth. However, this transition will require significant investments and holds serious challenges to be overcome by member states.

A climate neutral energy sector would mean that there either is no more conventional source for energy, but all energy is produced from renewables, or then the emissions produced using fossil fuels for energy are offset. As shown in the next chapter, a fully renewable supply of energy is not realistic by 2050 and therefore, ways to offset emissions need to be developed. Planting trees is one solution, but this requires that the trees can stay at their place for many years and that they are not removed elsewhere. With the current deforestation, this is not a reliable and viable option for carbon capture. (Fairs, 2021) Thus, other ways of carbon capture are needed. It has become clear that so far, the oceans and algae have been able to soak up way more CO2 than previously expected based on calculations. (World Economic Forum, 2019) However, in this document there will not be relied upon "luck" for the future emissions. The CO2 levels absorbed from the atmosphere by the oceans has prevented the global temperature to rise as fast. However, none of us know the impact yet of the effects of the ocean CO2 sink. (Shutler & Watson, 2020) At the moment, the effects of rewetting peatlands as a natural carbon sink are also being studied. Drained peatlands are another huge source of emissions from which could be prevented by rewetting the peatlands. (Tanneberger, et al., 2020)

More recently, a different more technical approach has been taken to combat emissions which cannot be completely reduced by 2050. Up to 90 percent of CO2 emissions from energy production can be captured at the industrial facilities that use conventional energy sources. CO2 can be used or converted into a liquid on site and transported via pipeline, boat, or by train. Against common belief, CO2 is actually used in a wide range of processes directly such as carbonated drinks or enhanced oil recovery or processed further through chemical processes to be used in synthetic and designer fuels or can be used to create polymers and plastics and it can even be processed into calcium carbonate, one of the core products of cement. (Roberts, 2019) However, most captured CO2 through this way is injected deep into the ground. This part of carbon capture is already widely used and available.

The remaining 10 percent of CO2 emissions will need to be captured as well and development for these has rapidly increased in the recent years. This method is called direct air capture or DAC. Currently, this technique of carbon capture is very expensive and only making its first steps into real production and implementation. For example, worlds first commercial DAC unit has been installed in Iceland in 2021. (Wilson, 2021) This project has been realized by investments from over eight thousand people and numerous firms, of which one is Swiss Re which has invested 10 million dollars through a contract with Climeworks, the company behind the first large scale direct air carbon capturing device. Swiss Re has not disclosed exact costs for the installation and its operating cost, but a press release has confirmed it to be several hundred dollars per ton of captured carbon. (McDonnel, 2021) At this very moment, the installation covers the emissions of about 870 cars which is not a lot. However, this is a beginning and proves that it is possible to capture CO2 from the air and store it deep in the ground until it turns into rock. (Sigurdardottir & Rathi, 2021)

3.4 ETS

The EU Emissions Trading Scheme (ETS) is the main tool for the EU to reduce the CO2 emissions of member states. The tool also applies to combat the negative externality of emissions produced by the energy sector. The ETS works as a cap-and-trade for emissions, the system of cap-and-trade limits the total emissions output and sets a price on the emissions. Under the ETS emitters can apply to purchase permits which allows them to emit certain tons of CO2. These permits can be traded. An example of this is one company that has invested in green energy and thereby emits less, which can sell their permits for a profit to another company which has not adapted to greener energy but is still using conventional resources for energy supply. The idea behind the ETS is to gradually lower the number of permits and force the CO2 emitting companies to a more sustainable form of energy production or to pay increasingly more money per permit as they become more valuable as the supply will be limited. (Pannell, 2011)

3.5 European Green Deal

Presented in December 2019, the European Green Deal states that there are three concrete actions for a strong basis to reach the set goal of a maximum of 1.5 degrees increase in global temperature by the end of this century. The first is for Europe to be the first climate neutral continent by 2050. This means a complete offset of all emitted carbon, of course while maintaining a secure and affordable supply of energy. (Eurofound, 2021) The second is to have a just transition fund, this is a fund based on the Just Transition Mechanism (JTM). This mechanism provides a support to soften the socio-economic blow which will come from realizing the cost of the climate change externality which has not been paid for in the last 150 years. The fund is aimed to reach 55 billion euros and aimed to lift the weakest areas in the EU to a more sustainable energy supply based on renewable resources. (European Commission, 2021) The last action is a sustainable Europe investment plan, this by creating directives and long-term strategies to reassure investors that sustainable energy sources will be considered for long-term investments. As well as helping to attribute a financial value to environmental performance of all other corporations, this helps defining funds which prefer to invest in only green companies to cross non-environmentally friendly corporations immediately off their list of potential companies to invest in. (European Commission, 2016)

Real future benefits of this Deal include net zero pollution, affordable and secure energy, smarter transport, and high-quality food. This deal holds a political tool, the financing plan of the EU. This is aimed mostly to invest in and nudge private investors to invest in environmentally friendly technologies, helping revolutionizing industries innovate, aiding the roll out of cleaner, cheaper, and healthier forms of transport, both public and private, while also decarbonizing the energy sector, making building more energy efficient, and eventually improving global environmental standards.

3.6 Progress towards these goals

The EU’s emissions, excluding the UK, in 1990 in million metric tons of CO2 were 3 753,9 and the latest figures from the 2020 results show 2 549.8. This is a reduction of around 32 percent. It means that the 2020 goals regarding emissions have been reached. The cause of this might be the COVID-19 pandemic which severely impacted the CO2 emissions. However, even if the 2019 values are compared to 1990, a 20 percent reduction in CO2 emissions has been achieved. (Tiseo, 2021) This was, however, only the beginning and most likely the easiest part. In 2006 the emission level was around the same as in 1990 so also the period in which the actual reduction was achieved was in 13 years instead of the whole 30 years between 1990 and 2020, which immediately shows a more positive outcome.

The second target, to have at least 20 percent of renewables in the energy mix has been nearly achieved in 2019 and stands at 19.7 percent. (Eurostat, 2020) This has more than doubled since 2004. Another milestone as good as achieved for the EU. The next ten years will be focused on reaching the new goal for 2030 to have 40 percent share of renewables in the energy mix. Together with increasing energy efficiency and funding directed towards renewables, this should be achievable.

Improving energy efficiency has mostly to do with acclimatization. Heating and cooling poorly insulated buildings are costly processes and a majority of European buildings have been built before the establishment of official requirements of energy efficiency. A lot of heat that is created as a by-product of industries is not being taken advantage of. Developing energy-circulating infrastructure and increasing buildings' energy efficiency is a way to reduce primary energy consumption. (European Commission, 2017)

The improvement in energy efficiency had to end up in a total primary energy consumption in the EU for 27 member states in 2020 of 956 million tons of oil equivalent, also called Mtoe. In 2019 the trend was just starting to even out after a period of growth since 2014 standing at 983 Mtoe of total consumption. With the COVID-19 pandemic in 2020, the consumption drastically fell due to stalling economic growth. (Climate Action Network Europe, 2021) This resulted in a yearly consumption of 935 Mtoe, which means that also the last goal of the 2020 climate and energy package has been successfully reached. (European Environment Agency, 2021) However, as in 2021 the economic growth is rapidly returning to the pre pandemic levels, which does not predict a stable improvement in efficiency to be relied on for the future goals as set out for the 2030 goals.

A combination of the three goals can be found back in Figure 2 below. The graph explains the CO2 equivalent emissions in grams per Kilowatt hour of electricity generated in the EU over a period from 1990 until 2020 with an indication forecasted which is necessary for achieving the 2030 goals, as well as the 55 percent net reduction compared to 1990 levels goal for 2050. As the graph shows, this line has been decreasing quite steadily over the last thirty years, also before the pandemic, and if more effort is put in, the decline will continue. In 2020 the countries ranged from 8.8 grammes to 774.9 grams per kWh. As this is nearly a factor 100 difference, there is definitely room for improvement in some places. Of course, funding and development from the EU will need to be directed more to the weaker places where more is to be gained. (European Environmental Agency, 2021)

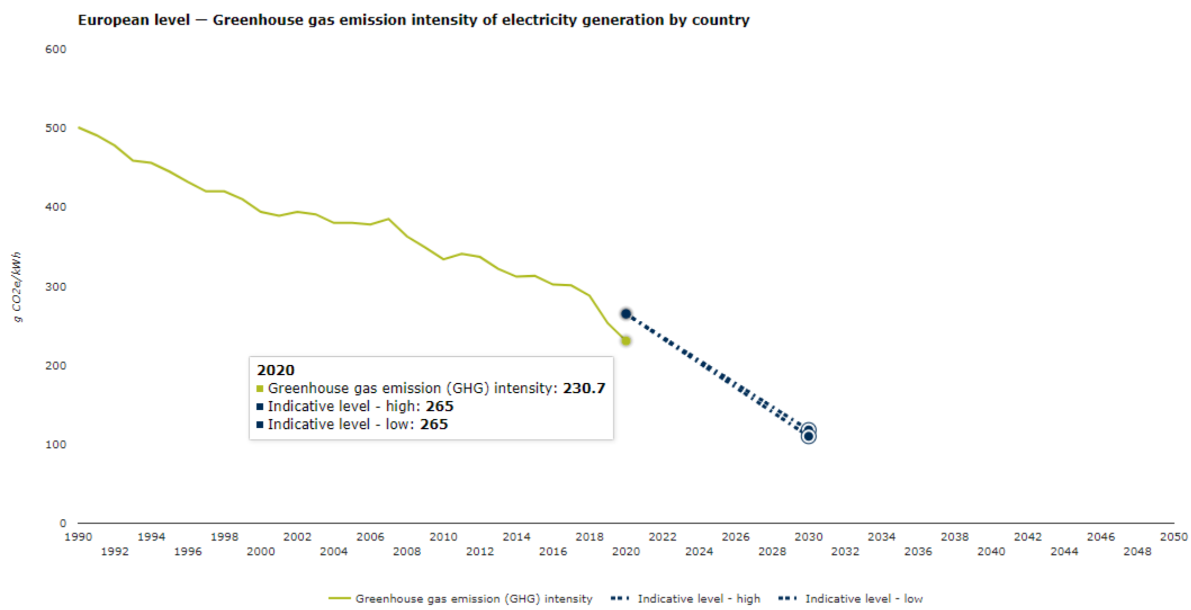

Figure 2, Greenhouse gas emission intensity of electricity, European level. (European Environmental Agency, 2021)

Although this forecast looks very promising, recent developments have been contradictory. Germany, the EU's largest energy producer, has in its new energy transition committed to eradicating nuclear energy from its energy mix. Currently Germany was well underway with a share of at least 40 percent renewable sources in its energy mix and 12 percent nuclear energy. Replacing conventional sources of energy with renewables is already a tough nut to crack. (Nickel, 2021) With the promise to stop using nuclear energy in the future, Germany has increased the difficulty of its future task because it must replace another 12 percent of its energy supply with renewables. In 2018 Germany had a 21.7 percent share of the EU total electricity generation, and together with a close second France, 19.9 percent share, and Italy 10 percent, make up for about half of the whole EU's electricity generation. There are 27 countries in total, which means that 24 countries make up the other half. France on the other hand has already a large part, around 70 percent of their electricity from nuclear energy due to a policy based on energy security. (World Nuclear News, 2021)

4 Into emission free competitiveness

4.1 Current EU energy consumption

The EU is undergoing an energy transition away from solid and liquid hydrocarbons as resources. The EU is so ambitious with its reduction goals, that the speed at which new renewable power plants are installed is not high enough to keep up. This leads to an at least temporary increase in the use of gaseous hydrocarbons as a power source. This temporary period of increase is expected to last at least until 2040.

In the graphs below, the EU's complete energy balances can be seen. The complete energy balance is also known as the gross inland energy consumption. Over the years a clear reduction in solid fossil fuels is visible, while oil and gas have kept their share of the totals. This can be explained by the development of countries' energy generation. This is a total picture of the EU; thus, it only shows an overview. When looked at it in more detail, countries seem to be approaching carbon-neutrality step by step rather than directly switching all conventional methods of energy production to renewables. For example, Germany is phasing out its coal fired power plants and replacing them with renewable energy sources. However, these new renewables are not able to be built in such a short time that the short term catch up with the loss of energy produced by solid fossil fuels and the loss of nuclear energy on top of that. Therefore, an increase in gas in the energy mix is very likely.

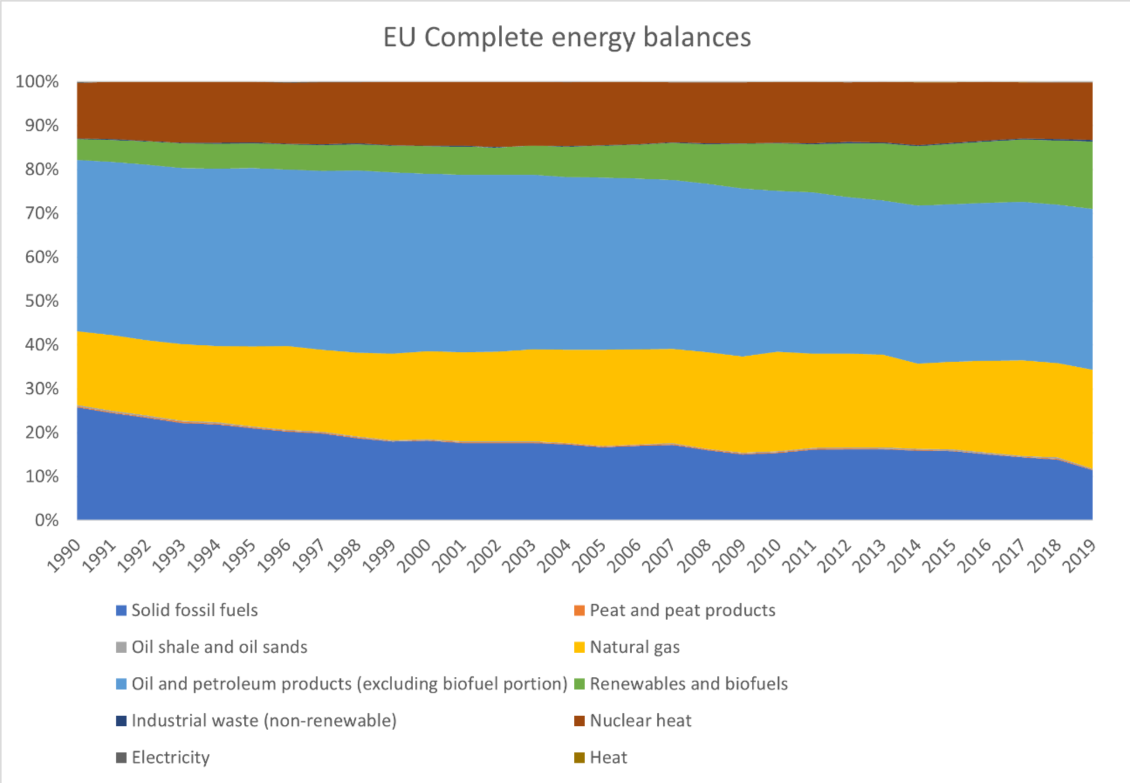

Figure 3 EU Complete energy balance in percentages of the total energy consumption. (Eurostat, 2021)

As all countries have a different energy mix, each country has its own priority. Most of the countries have already significantly reduced their reliance on solid hydrocarbons and are trying to replace their liquid hydrocarbon resources by gas, renewables, and nuclear. Other countries which were still highly dependent on solid fossil fuels in 2018 now have the task to get rid of those fast. As a result, these will be focusing on the massive gains to be gotten from switching from coal to oil or gas. When burning oil instead of coal, about one third less of raw material is needed. (Lizica, et al., 2020) Furthermore, per each unit of heat produced from oil instead of coal, as a byproduct one third less CO2 will be produced. (Paraschiv & Paraschiv, 2020) For the weaker countries in the EU which are still heavily dependent on solid fossil fuels, this becomes a valid way to reduce significant emissions and have less resource intensive energy production of which the costs are not even close to the switch directly into renewable sources of energy. Similarly, so for gas as an energy source, this produces about half the amount of emissions when compared to coal, and on top of that, the CO2 capturing devices installed in newer highly efficient gas power plants are able to filter 90 percent of those as well. As the richer part of the EU has already competitively developed these power plants, the costs of building these have significantly reduced. Especially when compared to renewable sources of energy as well as nuclear power plants the price for gas power plants is relatively low. Furthermore, solar panels and windmills occupy a massive amount of space compared to one larger gas power plant. (Gates, 2021: 58-87)

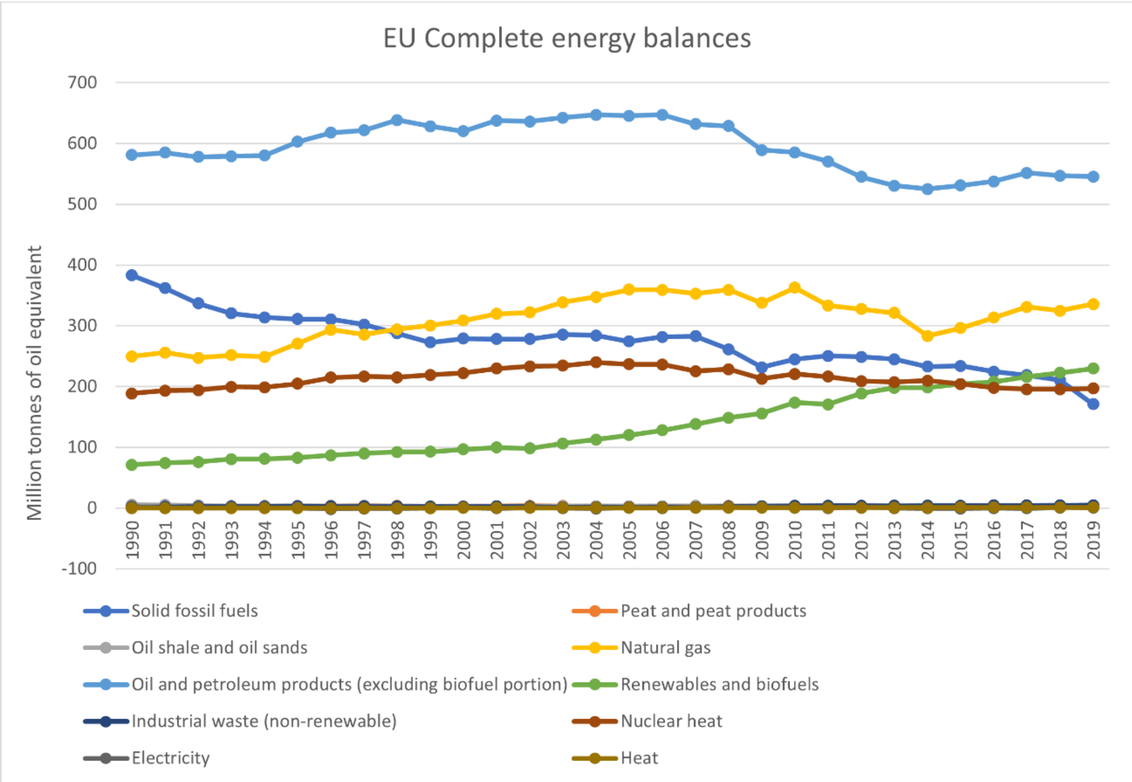

Figure 4, EU Complete energy balances as amounts in Mtoe. (Eurostat, 2021)

In Figure 4 above, the amounts of the sources can be seen. Oil and petroleum products, together with gas are the two main drivers of energy in the EU. The total of these two is not expected to decline soon as the reduction of oil is mostly going to be covered by gas. This is beneficial as gas is a more energy-efficient resource than oil. Furthermore, during the combustion of gaseous hydrocarbons less emissions are produced as a by-product, and these are more easily capturable as well, compared to liquid hydrocarbons.

The EU's energy demand cannot be met by the resources and extraction capabilities currently available in the EU. The EU currently has a critical energy security situation as the union is highly dependent on imports of energy resources. Furthermore, the extraction of fossil fuels from nature is being reduced in most member countries. One example is the EU's largest gas field in the northeast of The Netherlands. In 2019 this field alone has produced 12 billion cubic meters of natural gas, which is over 17 percent of all the gas produced in the EU. (Energi Danmark, 2019) This field is expected to stop production completely in 2022, which will lead to reduced production within the EU. (Rijksoverheid , 2020) Furthermore, another 19 billion cubic meters of gas produced in the EU came from The Netherlands in 2019. (European Commission, 2019) With that, the Netherlands was responsible for almost 48 percent of the total production of gas in the EU and this country is limiting the extraction in most of its gas fields. (Chong, et al., 2020)

Together with the already high dependency on imports of conventional energy sources, this further increases the vulnerability of the EU's energy security. In 2019, the EU was already 60 percent dependent on the import of energy. 43 percent of fossil fuels were imported, 97% of oil and petroleum was imported and 90% of natural gas was imported (please find more details on the numbers in Appendix A). (Eurostat, 2021) One major benefit of renewable energy sources is that there are many places in the EU where renewables can reach high efficiency rates. For example, there is consistent and strong wind in the areas just off the coast in the Baltic and North Sea. (Radu, et al., 2022) And solar power can reach near optimal levels in southern parts of Europe on the

Iberian Peninsula and on the land area just north of the Mediterranean. (Solargis, 2021)

However, the current dependency rate is still significantly above zero which would mean no more need for net import. The following information describes where the EU gets these resources from in percentages; the total sum of the percentages will always be 100 percent. In 2017, for solid fossil fuels; 38.8 percent came from Russia, 16.7 percent from Colombia, 16.5 percent from the United States of America, 11.6 percent from Australia, 4.8 percent from South Africa, and 11.6 percent from others, each individually less than 4.8 percent. For the imports of crude oil, 30.3 percent came from Russia, 11.4 from Norway, 8.2 from Iraq, 7.4 from Kazakhstan, 6.6 from Saudi Arabia, 6.4 from Nigeria, 5.2 from Libya, 4.5 from Azerbaijan, 2.7 from Algeria, 2.1 from Mexico, 1.0 from Angola, and 14.2 from other countries with less than 1 percent each. For natural gas in 2017 the EU was dependent for their imports; 39.8 percent on Russia, 26.2 on Norway, 10.7 on Algeria, 5.2 on Qatar, and 18.1 percent from other suppliers combined with less than 5.2 percent each. More details can be found in appendix A. This shows that for each import the EU is so heavily dependent on, a vast majority of the EU's imports rests on the exports of Russia. (European Commission, 2021)

4.2 Nuclear as an energy source

Even though nuclear energy is not a renewable, it can certainly help in the reduction of emissions. There is however a big drawback of common misconceptions and fear. Most importantly, Germany, the largest energy producer in the EU has declared that it will stop using nuclear power as a source of energy production. (Scherwath, et al., 2020) Nuclear power plants have no CO_2 emissions while operating, and the only emissions produced from nuclear energy originate from the extraction and refining of uranium ore. The EU has very little common policy on nuclear energy as countries themselves are responsible for their approach to this source of Energy. Within the EU the responsibility of nuclear regulation is a national responsibility. Therefore, each country has its own national nuclear energy policies, and these vary a lot between EU member countries. (Kanellakis, et al., 2013) As a result, many countries have a very different amounts of nuclear energy in their energy mix. France, for example, has achieved significant use of nuclear energy in its energy mix for electricity generation. This has a greatly reduced emissions impact when compared to energy produced by coal or gas.

There are a mere four countries in the EU which have less than 50 percent of their energy mix sources from the standard fossil fuels, solid fossil fuels, natural gas, and crude oil and petroleum products. These countries are Estonia with 8.9 percent, Sweden 27.8, Finland, 39.4, and France 48.2. Estonia is using oil shale and oil sands in a large share of their energy production. (Gagrilova, et al., 2020) This is even worse for the environment than coal. (Center for Biological Diversity, sd). However, France and Sweden are topping the list when looked at percentages contributed by nuclear sources for energy. France uses 32.9 percent of nuclear energy in their energy mix, and Sweden 42.3 percent. (Eurostat, 2020: 18-20) Sweden is currently topping the list of greenhouse gas emissions per capita in the EU as well the part renewables play in the energy mix of EU countries with 56.4 percent share for renewables. (Eurostat, 2021)

Nuclear energy is very often linked with extremely negative effects. Rosling describes the effects of irrational fear really well in his book *Factfulness*. As an example, Rosling uses the safety and fears of air travel to demonstrate the fear instinct. In 2016, roughly 40 million commercial passenger flights were flown, only ten of these had crash incidents with fatalities. Yet, many people still fear that if they travel by plane, they will get into a crash accident. (Rosling, et al., 2018) This can be similarly applied to nuclear power generation. As Gates presents in 2021, nuclear power has a death rate per Terawatt hours of energy produced of 0.07 while in comparison, coal has 24.6 and all other conventional fossil fuels are between 2.8 and 18.4 deaths per Terawatt hours. (Gates, 2021: 58-87) In the unlikely event of an incident with nuclear power, the outcomes are often widespread in the news. Even though the fatalities worldwide are low. In comparison fossil fuels have been estimated to cause 8.7 million deaths in 2018 due to air pollution. (Milman, 2021) To put that in perspective, that is around 20 percent of all deaths in 2018 globally.

Figure 5, The picture of the abandoned city of Pripyat after the Chernobyl nuclear incident of 1986. (Aliyev, 2021)

Figure 6, Pollution in New Delhi, January 2021. (Samad, 2021)

4.3 Germany and its issues

All EU member states are now reducing their most emission intensive power sources. On top of that, the Netherlands is reducing a gas surplus that could support the whole of Germany's current needs while Germany is reducing the coal surplus. (Marson & Wallace, 2021) This however is not aligned at all, and it seems that the EU will be heavily depending on Gas in the short term at least until 2040. (European Commission, 2016: 64) As the EU's largest producer of energy, Germany is slacking compared to the EU average when it comes to the transition to renewable energy sources. Germany, still heavily dependent on coal-fired powerplants and lignite consumption, has a hard time ahead. The mining of hard coal was ended in 2018 and there is a commission in force to phase out the remaining coal plants by 2038. While at the same time phasing out nuclear power, Germany faces a great issue regarding energy security while cooperating with Russia on a new gas pipeline, the Nord Stream II from Russia through the Baltic Sea straight to Germany. If Germany wants to phase out nuclear and achieve carbon neutrality by 2050 it seems very difficult with this forecast.

The only reason for which Nord Stream II can be necessary is to cover temporarily for energy supply in a transition period to renewables: from coal to renewables with gas as a middle checkpoint. However, Nuclear seems a more viable option at this point, also to reach 2030 and 2050. With Germany reducing Nuclear and Coal at the same time, there seems to be no other option than to increase demand for Gas. The Nord Stream II project would lead to a potential doubling of the Nord Stream I capacities. (Sziklai, et al., 2020) This is essential to compensate for declining European production. Furthermore, the increased supply would lower the costs of gas in a period in which the prices are increasing. Moreover, it would increase energy security as key pipelines from Russia to the EU through Ukraine are reaching the end of their estimated lifespan and the new route diverts from a reliance on third parties. The EU has already been victim of disputes between Russia and Ukraine and more recently Belarus is threatening to cut gas supplies to the EU over a political argument. (BBC News, 2021) A different route would reduce the reliance on third parties controlling access to energy resources for the EU.

4.4 Dependency on gas and Russia

However, the new pipeline and increased supplies would increase the dependency on Russia and therefore reduce the diversity of the EU's energy supply. As the EU is reducing its own gas production and is expected to use more gas as an energy source in the near future, increasing imports is a must. The only realistic and affordable increase in imports can be supplied by Russia, which is already the main supplier of gas to the EU. This increases dependency on a single source of energy and therefore reduces the energy security.

Relying on Russia for the EU's energy security may seem like an absurd gamble that would give Russia unwanted power or influence over the EU and reduce the effectiveness of the sanctions imposed on Russia by the EU following the annexation of the Crimea in 2014. If the EU's energy is largely dependent on Russia during some cold winter months, that directly lowers the EU's incentives to impose sanctions on Russia. Nevertheless, dependency between the EU and Russia is mutual. As the EU is largely dependent on energy imports from Russia, the EU is the most important export market for Russia. Especially now that the world is slowly transitioning towards a fossil fuel free, Russia has only a limited time to sell as much of its natural resources as it can before they become worthless, which can happen within 30 years from now. The modern Russia is built completely upon the fully state-controlled companies which extract and sell hydrocarbons. Russia's current economic system is driven by exports of natural resources and to start and sustain a transition, the country needs to have as much income from the natural resources before the value of these will disappear. (Romanova, 2021)

Another option to increase gas supplies would be to increase the imports of LNG. Currently, the LNG Terminals in the EU can supply 50% of EU gas demand, but they are currently only utilized at 27%. This shows that the infrastructure is available. (Cevrioglu, 2020) At this moment in the EU, LNG is much more expensive than straight up gas. The differences are so big that suppliers from the American continent do not see the EU as competitive enough compared to the prices paid by Latin American and Asian countries to necessarily increase supply to the EU. Currently the EU LNG yearly import is divided mainly between; Qatar 30bcm, Russia 21bcm, US 17bcm. Also, in the LNG market, Russia is a heavily depended on partner, whereas the US sees itself as a potential bigger player in LNG supplies. (Team Consult, 2017)

5 Studies comparing climate strategies

5.1 Hahnel and Stern

Two widely acknowledged publications regarding implementing climate change prevention into economic systems come from Nicholas Stern, *The Economics of Climate Change: The Stern Review*, and Robin Hahnel, *Green Economics – Confronting the Ecological Crisis*. Both argue that a new green political approach needs to be taken which is equitable and works economically. Both recognize the urgency of action since consequences of the quickly rising levels of greenhouse gases in the atmosphere are hazardous. Reducing future emissions requires a revised energy infrastructure with carbon capture mechanisms which demand substantial investments as the development of affordable emission-free technologies is not able to solve the increasing emissions in a timely manner. (Stern, 2006)

Hahnel focuses on establishing an economics of the environment that is largely based upon market-friendly alternatives and leans more towards preservation of our industrial economy than directly preserving the natural environment and preventing climate change, thereby giving climate change a lower priority than the economy. (Hahnel, 2011) Meanwhile Stern elaborates on models which lead to his conclusion that there are significant benefits in acting strongly and early that outweigh the economic cost of not acting. Therefore, Stern is more concerned about climate change and suggests a more urgent approach to the problem than Hahnel. This can be described by two opposite valuations of nature. Hahnel takes an approach in which the natural reserves are not extracted and therefore do not necessarily have the same value as something which is already produced by humans. This leads to nature's intrinsic values being left out of the economical scope. (Dunlap, 2011) The result: A proposal of higher return of investments exposed to less risks when renewables are used. Stern on the other hand has been criticized for using an extremely low time discounting rate in his economic modeling of climate change. Due to this economic reasoning with the specific utility function used by Stern, the Stern review justifies heavy and urgent actions against the current emission levels. (Nordhaus, 2007) It is extremely difficult to consider the many uncertainties about the future as well as the current climate change driven by mankind is not something which has happened before. Therefore, there is no consensus what this discount rate should be. (Weitzman, 2007) This should be considered when looking at the solutions that Stern justifies based on his analysis.

Stern focuses on the estimated costs of taking measures against climate change. The global economic risks that Stern puts forward in case no action is taken are extreme. This is further confirmed by the urgency of action to avoid a climate disaster, as argued by Gates. (Gates, 2021) According to Stern, due to a lack of a collective vision on the long-term goals with regards to emissions, it is very probable that the actions taken against climate change are insufficient to meet the goals. Yergin on the other hand is more positive about the future. Yergin shows that widespread participation has been active since the 1997 Kyoto Protocol and global collaboration has increased since. (Yergin, 2012) Gates emphasises the positive outcome by showing that developments in all sectors have led to a less emission intensive production. Furthermore, solutions to produce energy from renewable sources and carbon capture from the air is already possible. (Gates, 2021)

5.2 Economic costs of not acting right now

It is very clear that climate change is increasing the amount of natural disasters, also named climate disasters nowadays. This will increase the amount of money governments need to prepare for such events. (Field, et al., 2012) The EU is still in a pretty safe area away from hurricanes, deserts, and has relatively good coastal defenses against the rising seas. It does not mean that the current climate developments are posing more dangerous threats; forest fires are more common in the Mediterranean and rivers flowing outside their boundaries are becoming a more regular issue, while at the same time, periods of drought are increasing as well, thus water scarcity becomes more common and production of food suffers more often. (Cacciotti, et al., 2021) However, the EU as one of the richer areas in the world, is expected to support relief efforts when poorer areas in the world are struck by an increasing amount of heavier natural disasters. Normally preventing is less costly than repairing and the same goes for rebuilding after natural disasters. An example the construction of the Delta Works in The Netherlands, an extensive flood prevention system was a 5 billion US Dollars endeavor. However, compared to the costs of cleaning up the southeastern United States after hurricane Katrina was estimated at 108 billion US Dollars, over twenty times as much, aside from the inhumane suffering of the local population. (Ghitis, 2017)

5.3 Financial incentive global change

Furthermore, besides the costs that originate from natural disasters, it is expected that fossil fuel prices will start to rise more sharply in the near future. In 2021 already it was noticed that there was a record increase in energy prices. (Liboreiro & De Filippis, 2021) Another way the prices will increase is through legislation which includes the negative externalities of fossil fuels in the price of energy generation. For example, through the 2005-launched EU ETS, emission prices will be having a financial cost to the emitter which is steadily increasing towards 2050. (Lovcha, et al., 2022) In 2021, the EU is also updating its energy classification for energy.

On a more positive note, Denmark has been transitioning to renewable energy sources and able to increase energy efficiency, while reducing CO2 emissions from the energy sector at a decrease of energy consumption. This shows that there is financial gain to be achieved by going through the change to renewables as energy supply. Denmark has started the core for this change already after the global energy crisis in 1973 and has aimed for self-sufficiency in energy generation since. In 1981, the first subsidies for wind energy were introduced. (U.S. Department of Commerce, 2019) By 1987, the Danes had made it so far with their dedication that even beyond the European continent they were well known for their technological know-how. For example, in that year 96 percent of the US investment in wind energy was dedicated to projects in California. In that particular state, 90 percent of the installed wind generators were made in Denmark. (Yergin, 2012) More recently, Canadian firm Carbon Engineering is developing a method of capturing CO2 from the air and refining this back into hydrocarbon fuels at a much cheaper price than originally estimated. (Staedter, 2018) This can be used especially in sectors where more environmentally friendly fuels are far from available such as in airline transportation. With the current investments aimed more towards sustainable and environment friendly solutions, firms like Carbon Engineering and earlier discussed Climeworks have huge potential. (European Commission, 2021)

6 Conclusion

The unconventionals were once the fossil fuel reserves that were deemed unable to be extracted from nature. However, as the supply was reduced at certain times the price for the resource went up and the investments into research and development of ways of gathering these fossil fuel resources led to innovations which made unconventionals feasible. This is also possible with renewables. As much of renewables are not yet fully economically feasible, it can be compared with the historical unconventional fossil fuel reserves and there should be investments made to make more renewables feasible. With the help of a tax on fossil fuels the extra cost what is not being paid for climate change now, the process for renewables becoming feasible is sped up.

Currently the EU is well on its way, having reached the 2020 targets and on a decent trajectory towards the 2030 targets. However, the EU's transition into a fully carbon free energy system is still far away and even in 2050 the expectation is that much of the EU still relies on gas to back up a large set of renewables and a significant amount of nuclear energy. As Germany has planned to phase out nuclear energy production faster than coal, gas will be even more important in the short term and to keep gas prices competitive in the EU, the Nord Stream 2 pipeline will be playing a key role.

The Nord Stream 2 pipeline is creating enormous pressure on the EU's energy security with an increased dependency on Russia. It is clear that this dependency on Russia already exists in the supply of all fossil fuels. And it should be even more critical to not increase this dependency. However, with the Nord Stream 2, third parties are bypassed and political issues between Russia and third parties as well as issues between the EU and third parties will not be able to impact the supply of gas to the EU directly anymore. Therefore, a measure of vulnerability to energy security is also eliminated.

Furthermore, the EU is cooperating with third countries to develop pipelines from the southern Caspian Sea to develop new routes for gas inflow into the EU. Another important thing to keep in mind is that if the situation suddenly becomes very serious and unpleasant, the current LNG terminal infrastructure is only used at 27 percent of the full capacity. This means that LNG imports can increase nearly four times, at a costly price if necessary. Similarly, the EU has oil reserves to keep the energy supplies up for around 7 days in case of an emergency of which most are in Germany, the country which might be most impacted if it were to come to a situation in which Russia stops the supply of gas. In extreme situations The Netherlands still has the legal possibilities to continue extracting gas from the Groningen gas field.

Another conclusion to be drawn is that direct air carbon capture is a must. In the foreseeable future until 2100, it is impossible to prevent all emissions that originate from energy production. Therefore, investments in such companies are essential to the EU climate strategy. It is already possible to see the small successes regarding carbon capture companies such as Climeworks achieve based on huge investments as well as longer term commitment deals.

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