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DETECTING POLICY CHANGE: THE FOCUS ON NUCLEAR POWER IN EU ENERGY POLICY FROM 2006 - 2020

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by

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Preface

Even though it has been going on for decades, the debate around nuclear energy sparked my interest as it still seems to go hand in hand with the necessary controversy. "*The debate continues between those who fear the power of nuclear and those who fear what will happen to the earth if humanity doesn't use nuclear power*". Moreover, I am generally intrigued by the complexity of geopolitics where plentiful factors seem to be involved and in which (access to) energy appears to play an indisputable role. Like any other controversy, there are clear proponents and opponents among the Member States of the European Union (EU) when it comes to the deployment of nuclear energy. Hence, I was wondering what the deal is with nuclear energy within the EU and consequently, how this is documented in EU energy policy. In addition to my initial interest in the subject of nuclear energy, the course of 'Energy, Sustainability and Society' offered at the University of Twente, and taught by my second supervisor Dr. Frans Coenen, lured me into writing my graduation assignment about this topic. Finally, the book for the course "Global Energy Politics" by van de Graaf and Sovacool provided the necessary input for this master thesis.

"Energy is a strategic good for the survival of regimes, a massive source of pollution, and a major cause of social goods and evils" (Hess & Sovacool, 2020)

Abstract

Accounting for more than 75% of the EU's total greenhouse gas (GHG) emissions, the energy system is in need of a low-carbon transformation as demand continues to grow. Though often perceived as controversial, nuclear energy is argued to be a low-carbon alternative to fossil fuels that has the potential to support the achievement of international climate goals. Ergo, the following research intends to examine the extent to which EU energy policy focuses on nuclear energy and how this can be explained. The research method entails a content analysis of respective EU energy policy documents ranging from the first common energy policy (2006) to the 2020 report on the Energy Union using insights from various theories on the policy process, including the advocacy coalition framework (ACF), multiple stream framework (MSF), and science and technologies studies (STS). Looking at the policy documents as well as the divergent national approaches, there is no consistent nor prominent focus on nuclear energy in EU energy policy. Since only limited information can be extracted from the policy documents, the research strategy encompasses a detective paradigm that combines the results of the content analysis with the theoretical framework and other findings in order to provide evidence-based explanations for the meagre focus on nuclear energy in EU energy policy from 2006 until 2020. Research shows that this can be explained by a number of economic, environmental, political, technical as well as social factors. Examples include shocks or events in the geopolitical context, such as prior nuclear catastrophes as well as Germany's nuclear phase-out. Focusing events are proven to shape values and beliefs, naturally resulting in conflicting coalitions, and consequently, in a marginal and ambiguous focus on nuclear power in EU energy policy.

Keywords

ACF, Climate, Energy Policy, EU, MSF, Nuclear, STS

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List of Abbreviations

ACF	Advocacy Coalition Framework
CO_2	Carbon Dioxide
DSO	Distribution System Operator
EC	European Commission
EP	European Parliament
EU	European Union
GHG	Greenhouse Gas
IEA	International Energy Agency
MS	Member States of the European Union
MSF	Multiple Stream Framework
NE	Nuclear Energy ('NE', 'Nuclear' and 'Nuclear Power' are used interchangeably)
OPEC	Organization of Petroleum Exporting Countries
PET	Punctuated Equilibrium Theory
RES	Renewable Energy Sources
STS	Science and Technology Studies
UoA	Unit of Analysis

1. Introduction

1.1 Problem Description

Many scientists agree that current levels of GHG emissions are placing us dangerously close to a "hothouse earth" scenario, while the demand for energy continues to grow (Boccard, 2014; International Energy Agency, 2019a; Steffen et al., 2018). Given that the energy sector is responsible for more than 75% of the EU's total GHG emissions, there is an undeniable need for low-carbon alternatives to fossil fuels (Delbeke & Vis, 2019; European Commission, 2020c; International Energy Agency, 2020a). In this context, energy policy refers to the manner in which governmental actors, including the EU, deal with the political, economic, planning, environmental and social aspects of energy (Khatib & Khatib, 2014). Attributes of energy policy include legislation, international treaties, objectives and agreements, incentives to investment, taxation and guidelines for energy conservation among other public policy techniques (ibid.). In short, energy policies comprise governmental actions to organize energy demand and supply. The first common energy policy for the European Union arose in 2005 under the name of the 'Green Paper' (COM/2006/0105). Inherently, this policy calls for a sustainable, competitive and secure energy strategy in the EU (ibid.). Whereas the Paris Agreement (2015) sets out a global framework to combat climate change, the European Commission (EC) introduced 'the European Green Deal' (2019) as an ambitious set of climate policy initiatives for the EU to achieve net-zero greenhouse gas emissions by 2050 (European Commission, 2020b; COM/2019/640). The Energy Union (2015) is considered the leading policy instrument to achieve this (European Commission, 2020d; Eurostat, 2020c; COM/2015/080). As part of the European Green Deal, the EC proposed to raise the 2030 GHG emission reduction target to at least 55% by 2030 compared to 1990. Even though energy policy is about much more than sustainability (e.g., self-sufficiency, security, competitiveness, among others); climate and energy policies appear to be inextricably intertwined. Against this backdrop, nuclear power is argued to be a resilient as well as zero-emission 'clean' source of energy that has the potential to help countries in achieving both climate and development goals (World Nuclear Association, 2020; Saidi & Omri, 2020). Even if nuclear is a zero-carbon energy source, it is not literally clean given that radioactive waste is its imminent by-product (International Atomic Energy Agency, 2020; International Energy Agency, 2019b).

In 2018, the Renewable Energy Directive raised the EU's binding energy efficiency target for 2030 from 27% to 32% (European Commission, 2021a; Directive (EU) 2018/328). This concretely means that the 27 EU MS together are to obtain at least 32% of its total energy consumption from renewable energy sources (RES) such as solar, wind, hydro, tidal, geothermal and biomass by 2030 (according to Eurostat, the share of renewable energy accounted for 19.7% of the total energy consumption in 2019; appendix 13).

Even if this target is attainable, it still means that 68% of the energy consumption must come from other energy sources. Given that nuclear energy is generally not considered a RES, the following research paper aims to examine to what extent EU energy policy focuses on the deployment of nuclear energy in view of achieving their objective to produce low-carbon energy while meeting the EU's energy demand. To achieve this aim, the research analyses respective EU energy policy documents ranging from 2006, when the first common EU energy policy emerged, to the most recent report on the Energy Union in 2020 by means of a content analysis. The content analysis uses elements from the theoretical framework to determine if, and ultimately explain how EU energy policy evolved with regards to the focus on nuclear energy during this time. The modus operandi entails a detective paradigm that combines the results of the content analysis with elements of the theoretical frameworks and other findings. The research method will be further amplified in chapter 3.

In the aftermath of the catastrophes in Chernobyl (1986) and Fukushima Daiichi (2011), nuclear energy (NE) has become a rather controversial yet ongoing subject of debate. In addition to the more commonly known dangers of nuclear energy such as radiation and weapon development, non-degradable nuclear waste and high costs of constructing and maintaining nuclear power plants also contribute to its unpopularity. Germany's decision to exterminate nuclear energy by 2020 further increases the pressure to abandon nuclear power in Europe (European Parliament, 2020). In this regard, Morales et al. (2014) studied the preferences and demands of the public after the 'external' shock of the Fukushima Daiichi accident, hereafter referred to as the Fukushima incident, concluding that governments react and respond to various and sometimes contradictory expressions of the public opinion. In the same vein, Kitada (2016) confirms that the public opinion changed after the Fukushima incident. At any rate, Europe's share of energy generated by nuclear power is abating (Statista, 2020a; International Energy Agency, 2019b). Between 2006 and 2019, Eurostat (2021) recorded a 16.3% decrease in electricity generated from nuclear within the EU. Even if the global nuclear power capacity increased, mainly in Russia and Asia, more European nuclear power reactors have closed than opened in recent years (ibid.). At the same time, NE accounts for almost half of low-carbon electricity and more than one fourth of all electricity produced in Europe (Eurostat, 2020a; World Nuclear Association, 2020). Germany, Belgium and Spain all plan nuclear phase-outs, whereas Finland, France and Slovakia have nuclear plants under construction (World Nuclear Association, 2020). However, all these construction projects experience cost overruns and delays. Moreover, there are reconsidering sounds coming from Sweden and Italy (initially opposed) when it comes to the deployment of nuclear energy. Altogether, it becomes clear that there are highly divided sentiments towards NE among the MS.

What makes this particularly tricky is the autonomy of each MS, meaning that each EU country is entitled to decide upon their own energy planning. In any case, energy policy is about much more than reducing GHG emissions. It concerns (geo)politics, economics, society and technical developments, among others. Dayula (2012) argues that "*the success of modern civilization is fundamentally linked to the ability to harness energy, primarily in the form of fossil fuels like oil, coal, and natural gas*". In other words, the availability of natural resources for energy consumption, also referred to as energy security, is of paramount importance for most governments as energy is central to almost every economic activity. The International Energy Agency (IEA) defines energy security as "the uninterrupted availability of energy sources at an affordable price". In this respect, NE is argued to provide countries access to energy independence by supplying vast amounts of power at a relatively low cost (World Atlas of Global Issues, 2018). Apart from RES, energy production mainly relies on the burning of fossil fuels (appendix 5 and 6). Fossil fuels such as oil, coal and natural gas are carbon-based materials which are unevenly distributed around the world (United States Department of Energy, 2012). In this regard, most of the oil and natural gas reserves can be found in Saudi Arabia, Russia, the United States, Iran and Iraq (National Geographic, 2019). Although coal reserves are found in every country, the United States, Russia, China, Australia and India hold the largest reserves (ibid.). Around 42% of the world's oil is produced by nations in the Organization of Petroleum Exporting Countries (OPEC), and nearly half of that comes from Saudi Arabia, Iran, and Iraq. OPEC is an international organization or cartel comprising 13 non-EU oil-exporting countries listed in appendix 10 and founded in 1960 (ironically around the same time nuclear power started to get foot in the ground). Together, they account for approximately 40% of the global oil production and own around 80% of the world's oil reserves. This means that OPEC has a significant influence on global oil prices, thus energy security (Statista, 2020b). Along similar lines, EU energy import dependency exceeded 60% in 2019, whereas oil continued to be the largest source of energy with a 26% share (Eurostat, 2021). Although the primary energy production in Europe experiences a downward trend with regards to solid fuels as well as natural gas, oil and other petroleum products, this is countervailed by an increased import of primary energy and energy products, for instance from OPEC Countries and Russia (Eurostat, 2021; Appendix 11). This concretely translates into a doubled import of natural gas, making it the second largest import product in terms of quantities, apart from crude oil (ibid.). Russia is the EU's main supplier when it comes to crude oil, natural gas and solid fossil fuels (Eurostat, 2020; Appendix 11). There is a pipeline (Nord Stream) on the bottom of the Baltic Sea that transports gas directly from Russia to Germany, thus the EU internal market. Now that a second pipeline (Nord Stream 2) is about to be 'aired', Germany provides subsidies for gas users whereas the Netherlands offers subsidies to cut gas off.

In this policy paradox, contradictory policies of MS seem to cancel each other's climate and independency efforts out. Given that imports are concentrated among relatively few external partners, this might also come at the expense of the stability of the EU's energy supply. Energy dependency is argued to go hand in hand with both economic and security concerns, as exporting countries may manipulate the availability and thus price. In 2020, the 4th report on energy prices and costs was released as part of the 2020 state of the Energy Union report, warning about the high reliance on fossil fuel imports. After three years of consecutive rises, the EU's energy import bill continued to increase to €331 billion in 2018 (Council of the European Union, 2020; European Commission, 2020e). In the worst case, exporting countries may be politically volatile, corrupt or linked to terrorist networks. In this context, Krickovic (2015) stresses that the interdependence between Europe and Russia in the energy sphere provokes security tensions, leading to competitive foreign policies. Moreover, different stakeholders hold different interests, whereas Russia tends to draw its own plan opposing approaches from both OPEC and the EU (Deutsche Welle, 2021). In other words, the degree to which energy is used has far-reaching consequences, varying from international conflict to global climate change. Perhaps for this reason do Hess and Sovacool (2020) describe energy as "*a strategic good for the survival of regimes, a massive source of pollution, and a major cause of social goods and evil".* One may argue that it is literally and figuratively all about the distribution of power.

Long story short, solid fossil fuels, petroleum and natural gas still accounts for more than 70% of the EU's total energy mix (Eurostat, 2021; appendix 6). This means that the EU's energy mix is still dominated by imported fossil fuels, which concretely translates into vigorous international energy dependency as well as elevated concentrations of GHG emissions. Notwithstanding the disadvantages of energy dependency and considering that there is no infinite supply of fossil fuels, the foremost concern today seems to be the hot topic of climate change. Simply put, human activities such as burning fossil fuels produces the primary greenhouse gas carbon dioxide (CO_2) as a by-product whereas elevated concentrations of CO_2, result in a disruption of the global climate (Our World in Data, 2015; Ritchie & Roser, 2020; Soeder, 2021). Be that as it may, global energy consumption continues to increase, together with the demand for all fuels (International Energy Agency, 2019a). As a result, worldwide CO_2 emissions hit a record in 2018 (ibid.). According to the IEA, this significant increase was mainly due to higher electricity demands. Likewise, Boccard (2014) underlines the challenge of keeping up with the increasing electricity demand as it is argued to rise faster than economic growth. In other words, the gap between renewable energy and (other) carbon friendly alternatives to fossil fuels that meet the EU's electricity demand is to be filled.

In this respect, it is repeatedly argued to be impossible without the help of nuclear power that produces electricity (World Nuclear Association, 2020; Saidi & Omri, 2020). However, nuclear energy policy remains highly uncertain as national governments are actively trying to accommodate political pledges, public opinion, climate objectives and security of electricity supply (International Energy Agency, 2020b). It becomes clear that the EU's energy system must be decarbonized in order to meet climate objectives (Delbeke & Vis, 2019; European Commission, 2020e). In addition, there seem to be plentiful economic, environmental, political, technical, as well as social factors involved in shaping EU energy policy. For this reason, the following research will examine the extent to which EU energy policy focuses on NE since the first common Energy Policy for Europe in 2006 until the 2020 Report on the State of the Energy Union. In other words, the research aims to find out whether policy change, in the form of a shifting focus on NE, has taken place by means of a content analysis and consequently, what indicators, based on policy change theories, show that. The content analysis primarily focuses on policy documents as they are considered a reliable expression of what gets political attention. However, it is important to keep in mind that only limited information can be extracted from the policy documents. Hence, the content analysis is supplemented by additional findings that ultimately translates into a novel framework. Above all, the research aims to add evidence-based insights on how the focus on nuclear energy in EU energy policy developed and provide possible explanations for this.

1.2 Research Question(s)

Nuclear energy is a contested source of energy. Apart from the discussion about the risks vs. benefits of nuclear, on a short-term it is not realistic to count on RES to cover all energy demands (Trainer, 2015). Even if possible, it takes time before RES, or any other low-carbon alternative for that matter, can meet the entire energy demand whereas climate action is urgent (European Commission, 2020b; Steffen et al., 2018; Ritchie & Roser, 2020; Soeder, 2021). Against this background, NE can be seen as an interim solution to combat climate change and strengthen self-sufficiency on the short-term. Be that as it may, nuclear policy and the perceptions of the risks and benefits together with values and insecurities around NE remain uncertain, which in return affects its acceptability (International Energy Agency, 2020b; De Groot, et al., 2013). As the debate on nuclear continues, this thesis examines whether it is an actual impetus for policy change. In order to do so, several frameworks are put forward to explain the development of policy on these types of contested issues. In view of the bounded scope of the research project, the theoretical framework predominantly focuses on three frameworks, namely: Kingdon's Multiple Stream Framework (MSF), Sabatier's and Jenkins-Smith's Advocacy Coalition Framework (ACF), and Hess' and Sovacools's Science and Technology Studies (STS).

Kingdon's MSF builds upon the garbage can model and provides great flexibility while Sabatier's ACF is a more structured approach as it recognizes well-established subsystems with relatively stable actor constellations. STS brings scientific knowledge, technological systems and society together. The debate rages on as to which of these frameworks is most adept at explaining how policy develops in the EU. Hence, this thesis is situated within these debates and asks the following research questions:

I. To what extent did EU energy policy focus on nuclear energy in the period that spans 2006 to 2020, and how can this be explained?

1.1 How can theories of policy change be used to explain and understand the position of NE in EU energy policy?

1.2 To what extent did the attention given to NE in EU energy policy evolve based on EU energy policy documents?

1.3 How can the elements of policy change detected in the policy documents explain the involvement of NE?

Against this backdrop, the following hypotheses are composed:

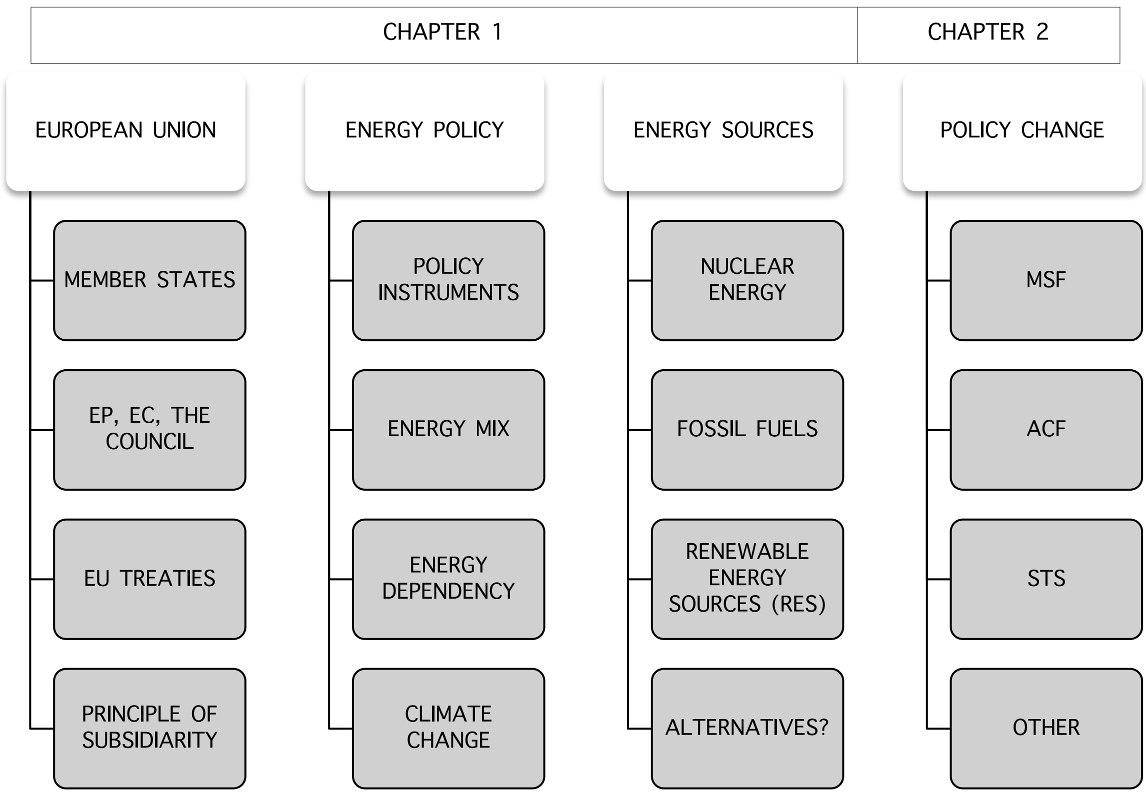
H1 Even though there seems to be an increased need for low-carbon alternatives to fossil fuels, the focus on nuclear power in EU energy policy documents is fading.

H2 The fact that there are insufficient other alternatives for low-carbon energy resources that meet the EU's energy demand is not considered in EU energy policy.

1.3 Conceptualization

For the purpose of the research, the concepts of the EU, energy policy, policy change as well as energy sources, including nuclear, must be clear. Whereas chapter 1.1 briefly introduces the concepts of nuclear energy, energy policy, climate change, energy dependency, RES and fossil fuels, this chapter further elaborates on the concepts of the EU, EU energy policy and energy sources including nuclear and fossil fuels. These concepts are broken down into subconcepts as shown in figure 1. Chapter 2 predominantly deals with the concept of policy change, its theories and core elements.

Figure 1 – Overview Conceptualization



The EU is an international organization comprising 27 autonomous European countries, also known as Member States (MS). Moreover, the EU comprises three main organs, namely i) the European Commission, representing the EU as a whole, ii) The European Parliament (EP), representing EU citizens, and iii) The Council of the European Union, also referred to as 'the Council' or 'Council of Ministers', representing each MS (not to be confused with the European Council or Council of Europe). The Council and EP are the main decision-making bodies of the EU.

The EC is considered the EU's overarching body that promotes the general interests of the EU, shapes a common strategy and proposes new laws. The EP reviews these proposals and passes decisions together with the Council of the European Union. The EC, EP as well as the Council, thus the EU as a whole, are limited in their competences. The principle of subsidiarity emphasizes that as a rule, the sovereignty of MS prevails. This means that if intervention of the EU is not necessary, decisions are retained by MS. The EU only intervenes when Member States' power is insufficient. This means that albeit the EC sets out the common vision for a climate neutral Union, each MS is entitled to decide upon their own energy planning. The exact competences of the EC, EP and the Council are defined in the EU treaties (Treaty on the functioning of the European Union – TFEU). Since MS design their own energy mix, the decision whether and how to deploy nuclear power is also made on national level.

The EU's limited competences as well as the prevailing autonomy of the MS represent one of the major challenges for EU energy policy, as it counteracts a uniform strategy. Given that each MS decides how to implement EU energy policy, it naturally results in contradicting efforts (policy paradox). Consequently, the necessary reductions in GHG emissions that meet EU objectives as well as the commitments under the Paris Agreement require voluntary cooperation by the MS (European Commission, 2020a). Nevertheless, European Union policymaking can be impactful, and the EU has a number of instruments at its disposal to encourage MS to abide by EU laws and policies (European Environment Agency, 2021). EU energy policy specifically refers to the agreements between the EU MS concerning energy development, including energy conversion, distribution and use. Attributes of energy policy include legislation, international treaties, incentives to investment, guidelines, taxation and other public policy mechanisms. Despite these policy instruments, the EU cannot force MS to invest expensive nuclear reactors. Langsdorf (2011) recognizes energy policy as one of the most important political issues as it is undeniably entwined with climate change, making it one of the most complex issues as well as one of the topics with the highest priority within the EU. Energy policies are generally made at the nation state level whereas some actors fight against more competencies for the EU. Areas of disagreement include the energy mix of countries, energy dependency and the access to energy sources, funding of future energy investment and as expected: the deployment of nuclear energy. Be that as it may, nuclear's green recognition is still on the EU agenda. For the purpose of this research, EU energy policy refers to the policy documents used for the analysis.

The Energy Union is considered the leading policy instrument to achieve net-zero GHG emissions by 2050. Besides decarbonizing the EU economy, the Energy Union aims to diversify Europe's energy sources, ensure energy security, create a fully integrated internal energy market, improve energy efficiency, reduce dependency on energy imports, drive jobs and growth as well as support breakthroughs in low-carbon and clean energy technologies (European Commission, 2020d). In other words, the Energy Union policy aims to bring secure, sustainable, competitive and affordable energy to all EU consumers (ibid.). By the same token, the EC proposed to further reduce the EU's GHG emissions with 55% compared to 1990, instead of the initial 40%, by 2030 (European Commission, 2020). Furthermore, EU MS share electricity across their borders. In the aftermath of the Second World War, national power grids of European countries became increasingly interconnected. Although European countries interconnect with power grids of neighbouring countries as shown in image 1, their capacity is limited (Planete Energies, 2016). Nonetheless, the cross-border power lines allow countries to meet their energy needs and help one another in the event of energy shortage. In case of a shortage, European countries buy and sell electricity among themselves, exchanging between 100 to 120 TWh of power per month on average (ibid.).

Image 1 shows a satellite picture of Europe at night, showing the interconnected European power grids. This unified system for cross-border electricity trading enables countries to help each other out in the event of power shortages (NASA, 2016).

Nuclear power produced electricity for the first time in the 1950's. It is generated through the process of splitting uranium atoms (fission) that produces heat and steam to ultimately generate electricity (appendix 3). Nuclear energy does not emit CO_2 but does produce nuclear waste. In addition, investing in nuclear reactors requires big investments before economic advantages can be observed (World Nuclear Association, 2021). To interpret energy statistics, it is necessary to distinguish between primary and secondary energy products (appendix 2). A primary energy product is extracted or captured directly from natural resources, such as uranium, crude oil, natural gas or coal. Coal, crude oil, and natural gas are carbon-based materials, and all considered fossil fuels because they were formed from the fossilized, buried remains of plants and animals that lived millions of years ago (The Natural Resources Defense Council, 2021). Fossil fuels are argued to be accompanied by considerable hidden costs associated with economic, health and environmental impacts (National Geographic, 2019). In addition, they are unevenly distributed around the world (United States Department of Energy, 2012). However, it is also considered an attractive energy source since it produces highly concentrated energy and can be transported with relative ease. Uranium is a relatively common metal found in rocks and seawater and more evenly distributed around the world as it is found in recoverable concentrations as well as in many geological settings (National Geographic, 2019; World Nuclear Association, 2021). The highest concentrations are found in Australia, Kazakhstan, Canada, Russia and Namibia. The World Nuclear Association (2021) claims that no shortage of uranium is expected for decades or even centuries to come. Secondary energy products are a result of a transformation process and include electricity or gasoline. Energy comes in various forms but falls into two distinct categories: potential (stored) and kinetic (in motion) energy (appendix 1). These categories can be broken down into chemical, electrical, radiant, mechanical, thermal and nuclear. Each of these forms can be converted into other forms. For example, nuclear energy produces electricity, whereas electricity may produce heat (thermal) and/or light (radiant).

In 2019, nuclear power plants generated around 26.4 % of the electricity produced in the EU-27. The European Union counts 106 operable nuclear power reactors (appendix 7). However, NE only represents the lion's share of the electricity supply in France and Slovakia as of 2020. According to the World Nuclear Association (2021), the largest producer of nuclear power within the EU-27 in 2019 was France, with a 52.1 % share of the EU total, followed by Germany (9.8 %), Sweden (8.6 %) and Spain (7.6 %). These four MS together produced 78.2 % of the EU's total electricity generated in nuclear facilities (ibid.).

1.4 Overview Thesis

This thesis is structured as follows. The first chapter sets out the concepts of the EU, energy policy and energy sources including nuclear, fossil fuels and RES. Moreover, the introduction deals with the problem description, background information and introduces the policies that are central to this research. In order to test the proposed theories, four research questions and two hypotheses are formulated. Chapter 2 deals with the first sub-question as it reviews and evaluates literature on policy change theories and examines how these can be used to explain the position of NE in EU energy policy. Based on the findings of chapter 1 and 2, specific expectations for the focus on NE in EU energy policy are formulated in chapter 2.5. Chapter 3 further amplifies the research method and elaborates on the choices for the research design. Chapter 4 discusses the results of the content analysis and its interpretation that lead to research question 1.2, 1.3, as well as hypothesis 1 and hypothesis 2. In chapter 4.5, the findings are evaluated, summarized and moulded into a new framework like a detective offering substantial evidence. Altogether, this leads to the central research question. The process as a whole as well as the scientific relevance of the research are discussed and reviewed in chapter 5. This chapter deliberates on the strengths and weaknesses of this thesis project whereas the conclusion in chapter 6 summarizes the main findings of the research.

2. Theoretical Framework

This chapter primarily aims to select, evaluate and eventually use frameworks of policy change theories in order to create a better understanding of the position of NE in EU energy policy. The theoretical framework intends to apply elements of various theories to explore if and how the focus on NE in EU energy policy evolved and thus answer sub-question 1.1. Before policy change theories can be used to detect shifts in EU energy policy, the concept of policy change will be discussed. Howlett and Cashore (2009) describe policy change as a homeostatic process, whereas the definition of homeostasis is described as "a self-regulating process by which systems tend to maintain stability while adjusting to conditions that are optimal for survival" (Britannica, T. Editors of Encyclopaedia, 2020). This means that policies evolve to fit its surroundings, thus depend on and adjust to external factors and events. Policy change is often argued to be incremental, yet short periods of abrupt change are also gaining foot in the ground when it comes to unscrambling policy change (Baumgartner & Jones, 1991; Kulovesi & Oberthür, 2020). In the same vein, Howlett and Cashore (2009) argue that durable policy changes can be explained by means of "perturbations" existing outside an institutionalized policy subsystem, usually in the form of societal or political disruptions or learning. Likewise, Hermwille (2016) argues that vivid examples co-determine policy responses. At any rate, this research aims to find out whether policy change, in the form of a shifting focus on NE, has taken place, and identify what indicators, based on policy change theories, show that.

The energy social science research field has no clearly defined boundaries and comprises a very wide range of conceptual frameworks from many disciplines (Hess & Sovacool, 2020). Moreover, each change theory has its own strengths and weaknesses and applies differently across policy areas (OECD, 2013). Strengths and limitations of the policy theories are being explored by analysing and comparing, to ultimately build further upon them. In view of the scope of this research project, three theoretical frameworks have been selected, namely: Kingdon's Multiple Stream Framework (MSF), Sabatier's and Jenkins-Smith's Advocacy Coalition Framework (ACF) and Hess' and Sovacool's Science and Technology Studies (STS).

Table 1 – Selected Frameworks

	Framework	Author	Year
1.	Multiple Stream Framework (MSF)	Kingdon	2003/[1984]
2.	The Advocacy Coalition Framework (ACF)	Sabatier	1988
3.	Science and Technology Studies (STS)	Hess & Sovacool	2020

Both ACF and MSF are prominent approaches and are often used for comparative policy analysis, whereas STS is a more interdisciplinary field that studies how scientific knowledge and technological systems came to be (Béland and Howlett, 2016; Bandelow and Hornung, 2017). When looking at the three selected frameworks, there are clear differences as well as similarities. Prima facie, ACF represents the most structured framework of the three and rejects the garbage can model, whereas both MSF and STS acknowledge a certain level of 'ambiguity' when trying to explain policy change. A literature review attempts to extract the necessary conditions for policy change from each framework. Many authors have recognized the strong potential of combining different theoretical approaches for a more complete understanding of empirical phenomena. The exploration of the intersections of MSF, ACF, STS and energy social science ideally leads to further development and refinement of the respective theoretical frameworks (Hess & Sovacool, 2020). The identified conditions from each framework are expected to be observable in the policy documents and will therefore be translated into codes and used for the content analysis.

2.1 Multiple Stream Framework (MSF)

John Kingdon's (2003/[1984]) Multiple Stream Framework (MSF) offers a dynamic approach to policymaking and is regularly used by scholars of agenda-setting and decision-making since it implies that policymaking is not a rational response to clearly defined social or economic problems (Johannesson and Qvist, 2020; Zohlnhöfer & Rüb, 2016). Instead, the MSF suggests that there is no systematic nor consecutive relation between a problem and a solution that is put forward to solve that problem. The MSF identifies three parallel and mostly independent streams that are involved in policy development, namely: problems, policies and politics (Kingdon, 2003; Johannesson & Qvist, 2020). According to Kingdon (2003), a potential for policymaking, commonly known as a policy window, appears when the problem, policy, and political streams are coalescing. Kingdon argues that policy changes, but only when new solutions are made more consistent with existing practices. In addition, the MSF builds further upon Cohen's et al. (1972) garbage can model (GCM) and is often used to elaborate on decisions in situations of uncertainty and ambiguity (March, 1991; Zahariadis, 2008). In other words, it provides some sort of reasoning behind the seemingly random solutions to problems by taking different streams into consideration. Moreover, it stresses the importance of ambiguity and situational configurations that may influence the behaviour of actors (subsystems) within the policymaking process. In return, the MSF provides great flexibility as there is no need for a detailed codebook, to test hypotheses, or advance general policy theory. Nonetheless, the lack of testable hypotheses is also criticized by Sabatier (2007) and Zohlnhöfer and Rüb (2016).

Akin to Hermwille, Jenkins-Smith and Sabatier, Kingdon (1984) argues that external focusing events, such as crises, accidents or the presence or absence of policy entrepreneurs open policy windows, which in return has the potential to trigger policy change. Kingdon (1995) and Lustick (2011) portray policy entrepreneurs as *"the well-informed and well-connected insiders who provide the knowledge and tenacity to help couple the 'streams'; yet they cannot do more than their environments allow. They are 'surfers waiting for the big wave', not Poseidon-like masters of the seas"*. According to Kingdon's MSF, focusing events and/or policy entrepreneurs play a vital part in shaping policy. Key concepts of the MSF, including policy entrepreneurs as an actor pushing for a particular policy, are often used in other theoretical frameworks such as Baumgartner's and Jones' punctuated equilibrium theory (PET) in 1993 (Jones et al., 2018). The punctuated equilibrium model of policy change entails a conceptual framework for understanding the process of change in complex social systems (ibid.). PET studies the evolution of policy change, including the evolution of conflicts. Given that policymaking is increasingly marked by complex problems and disagreements between policy actors and/or experts about appropriate courses of action, Johannesson and Qvist (2020) argue that the MSF is more relevant than ever. At the same time, Simon's (1992) theory on bounded rationality stresses that decision-makers are subject to cognitive limitations in making choices and claims that finding the optimal choice falls or stands with the availability of information at a specific moment in time. Moreover, Zohlnhöfer and Rüb (2016) argue that some of Kingdon's key concepts including 'policy-window', 'window of opportunity', 'policy entrepreneur' and 'focusing event' lack clarity and analytical precision as they are often used while neglecting the theoretical implications. This means that the theoretical generosity of the MSF is counterbalanced by a lack of scholarship (Zohlnhöfer and Rüb, 2016; Zahariadis, 2007). Primarily for this reason, the theoretical framework is supplemented by other eminent frameworks in social sciences.

Table 2.1 – Codebook MSF

Codebook Multiple Stream Framework (MSF) John Kingdon (2003/[1984])	
Code	When to use
1. MSF_ambiguity	The ambiguity of actors and the importance of situational configurations that may influence the behavior of actors within the policymaking process
2. MSF_beliefs	The 'national mood' and the feedback they receive from interest groups and political parties.
3. MSF_focusingevent	External focusing events such as crises and accidents. Also called a focus event, triggering event, or "perturbations" existing outside an institutionalized policy subsystem, usually in the form of societal or political disruptions or learning. This

	kind of occurrence, typically exogenous, can make government decision-makers aware of the existence of a problem. A shift of attention may relate to a ‘focusing event’ or the sense that a well thought out solution already exists.
4. MSF_policyentrepreneur	Well-informed and well-connected insiders who provide the knowledge and tenacity to help couple the ‘streams’. Actors known as ‘policy entrepreneurs’ develop solutions in anticipation of future problems, seeking the right time to exploit or encourage attention to their solution via a relevant problem (‘solutions chasing problems’).
5. MSF_policymakers	Policymakers have the motive, opportunity and authority to turn a solution into policy.
6. MSF_policystream	Policy instruments used to achieve goals.
7. MSF_policywindow	When the problem, policy, and political streams are coalescing.
8. MSF_politicsstream	Socio-political factors, including public opinions as well as organized political forces (coalitions) that shape policy
9. MSF_problemstream	When a problem is identified.

2.2 The Advocacy Coalition Framework (ACF)

Sabatier’s and Jenkins-Smith’s Advocacy Coalition Framework (ACF) argues that people translate their beliefs into policy and form coalitions accordingly. The sentiment around nuclear energy is rather divided, which results in opposing coalitions (e.g., oppositions within national governments or MS having their own energy policies and energy mix). The framework emphasizes the distinctive role of policy actors (subsystems) in policymaking. According to Sabatier and Jenkins-Smith (1994), subsystems are actors, including participants, that attempt to influence policy (e.g., government officials, private or non-private organizations, experts, scholars and media among others). Much like Kingdon’s policy entrepreneurs, subsystems would then also be subject to bounded rationality (Simon, 1992). In essence and equivalent to PET, ACF aims to create a better understanding of factors associated with policy change and theorizes policy action within a complex policymaking system (Cairney, 2019). According to Jenkins-Smith and Sabatier (1994), factors that influence policy change include the formation and maintenance of coalitions, the propensity for learning and the role of science and technology in the policy process, among others (Weible, 2017). Depending on the coalition structure, internal as well as external shocks can also lead to policy change (Yun, 2016; Kingdon, 1984). According to Jenkins-Smith and Sabatier (1994), “the ACF was developed to provide a causal theory of the policy process”. Further, the ACF assumes that policy actors (subsystems), thus people, engage in politics to translate their beliefs into policy and that they form coalitions accordingly. Sabatier suggests that people in the policy-, problem- and politics streams (MSF), directly interact in advocacy coalitions.

To put it differently, subsystems assemble policy actors into one or more advocacy coalitions with similar beliefs and compete with other coalitions. However, the same policy actors are argued to be boundedly rational and have limited cognitive abilities to process information (Simon, 1992; Jenkins-Smith and Sabatier, 1994; Weible, 2017). In short, the ACF provides a lens to see the policy actors as members of coalitions. These coalitions are formed based on similarities and differences in policy core beliefs and can therefore be applied to e.g., France as nuclear proponents and Germany as nuclear opponents (Weible, 2017; European Commission, 2021b). The ACF assumes rather stable belief systems that define coalitions and shape decision-making. In this regard, policy changes are rarely assumed to be the result of changes in beliefs, but more likely to be explained by 'who is in power' or 'the winning coalition' (e.g., left vs. right). Although uncommon, in some cases beliefs may change because of past experiences or as a result of arguing advocacy coalitions. In this regard, the ACF defines learning as a permanent change in the belief systems of subsystem actors (Kübler, 2001). Furthermore, the ACF analyses change over a full policy cycle whereas it rejects the black box theory as well as the garbage can theory. However, the ACF is also accused of infrequent and even inadequate application of concepts, particularly in the environment and energy domain (Pierce et al, 2020). Generally, the ACF is more structured compared to the MSF as it recognizes established subsystems with relatively stable actor constellations. In short, the emphasis of the ACF approach is on actors that form coalitions together with the resources and strategies to respond relatively well to events (internal and external shocks).

Table 2.2 – Codebook ACF

Codebook Advocacy Coalition Framework (ACF) Sabatier (1988)	
Code	When to use
1. ACF_authority	The governmental authority/power or ultimate decision-maker in a subsystem. 'Governmental authorities' may be formally responsible for policy decisions, but policymakers and influencers interact closely and may be members of advocacy coalitions.
2. ACF_action	Action takes place in subsystems, surrounded by a wider political system.
3. ACF_beliefsvalues	Policy core beliefs provide the glue to hold actors together, cooperate, and learn how to respond to new information and events and often to compete with other coalitions. Refers to the social structure and fundamental sociocultural values.
4. ACF_coalitions	More than one dominant actor. People with shared beliefs form coalitions. Coalitions influence how key actors understand, interpret and respond to external factors and/or events.
5. ACF_constitutional	Basic constitutional structure.

6. ACF_externalesources	Distribution of natural resources.
7. ACF_institutional	Type of institutions involved, also referring to various levels and types of government.
8. ACF_learning	Knowledge produced from outside the subsystem by an actor within the subsystem to inform policy change. Continuously adapt to new information about policy and their policymaking environment. Learning is a political activity, driven by actor's beliefs. People learn how to retain their coalition's strategic advantage and select or interpret the information they hold to be most relevant.
9. ACF_policy	A course or principle of action adopted or proposed by an actor or coalition.
10. ACF_policybrokers	The actors present within many (not all) subsystems that seek to minimize conflict and produce workable compromises between advocacy coalitions.
11. ACF_policyimpact	Measured/observed effects and/or results of a policy.
12. ACF_policyoutput	Sequence of related sets of variables; push and pull of several factors.
13. ACF_problem	Basic attributes of a problem area involving substantial goal conflicts, important technical disputes and multiple actors from several levels of government.
14. ACF_shocks	Shocks are the combination of external events and the reaction by coalitions. An occurrence such as the election of a new government with new ideas, or the effect of socio-economic change or "perturbations" existing outside an institutionalized policy subsystem, usually in the form of societal or political disruptions or learning. Events may prompt major change as members of a dominant coalition question their beliefs in the light of new evidence (external shock) or another coalition may adapt more readily to its new policy environment and exploit events to improve its position within the subsystem (internal shock). Internal and external 'shocks' affect the positions of coalitions within sub-systems.
15. ACF_strategy	A plan of action designed to achieve a long-term policy, belief or overall aim. The proposed way in which coalitions intend to achieve their goals, usually in the form long term plans/policies. Greatly varies per MS.
16. ACF_subsystems	When policy actors (subsystems), thus people, that engage in politics to translate their beliefs into policy and form coalitions.
17. ACF_subsystemresources	Means to achieve policy(s) (e.g., money, time, (access to) raw materials etc).

2.3 Science and Technology Studies (STS)

Science and technology studies (STS) represents the third and most technical theoretical perspective towards policy change compared to the ACF and the MSF. This framework is selected as it focuses on the relationship between scientific knowledge, technological systems and society and underlines the co-constitutive relationship between man and technology (Weible, 2017). STS is a multidisciplinary field of science and technology studies that goes beyond social sciences. It deals with differences in technological systems but goes further than only technical criteria like functionality, cost and efficiency as it produces scientific knowledge through networks of both human and non-human actors. In this respect, Hess and Sovacool (2020) describe STS as a field is in the middle of epistemological relativism (social) and naïve realism (science and technology). To put it differently, STS brings different disciplines that have the potential to broaden insights on the development of energy policy together. Although Jenkins-Smith and Sabatier (1994) also recognize the importance of science and technology in the policy process, the MSF and ACF represent more social science approaches, whereas STS represents a research field that provides the capacity to see the interconnections, mutual shaping, co-constitution, or coproduction of the technical, social, and natural worlds (Hess & Sovacool, 2020). In the same vein, Hess and Sovacool (2020) argue that STS in energy social science analyses matters that otherwise might be overlooked (also referred to as the black box of sociotechnical matters or the unexamined nexus of social and technical matters). Nonetheless, critics of STS question the degree to which the boundaries between nature and culture, belief and reason, humans and nonhumans are guided by 'Western-knowledge'. At the same time, elements of STS are often operationalized into measurable elements such as costs, functionality, efficiency etc. Since STS also considers how socio-technical elements affect scientific research and technological innovation, it is considered complimentary to the ACF and MSF. An example of STS in practise is the development of 'smart grids' (appendix 12). Simply put, electrical or transmission grids are interconnected networks that transport electricity from producers to consumers. Distribution system operators (DSOs) are the operating managers of these energy distribution networks. Smart grids incorporate additional technical solutions to the same networks, such as enhanced communication instruments or sophisticated sensors that allow DSOs to actively manage fluctuating energy demand and generation (European Distribution System Operators, 2021). Another example is the Pan-European Hybrid Electricity Market Integration Algorithm (Euphemia). This algorithm tracks every buy and sell bid submitted to the participating national and regional power markets. Euphemia integrates the world's largest synchronized power grid. The aim of this technology is to maximize the "social welfare", meaning that the overall costs for consumers will be minimized by using the most efficient power supplies (The Institute of Electrical and Electronics Engineers, 2014). In short, STS brings social and technology sciences together.

Table 2.3 – Codebook STS

Codebook Science and Technology Studies (STS) Hess & Sovacool (2020)	
Code	When to use
1. STS_science	Scientific knowledge or the systematic study of the structure and behaviour of the physical and natural world through observation and experiment.
2. STS_society	Social and cultural perspectives including networks, users, firms, states, social movements, social structure, race, class, gender, sexuality, national original, global position, values, cognitive categories, institutions, and so on. Grouping of humans.
3. STS_sociotechnical	Matters that are both social and technical. Also refers to the contested ways in which sociotechnical and material futures are imagined and strategically deployed.
4. STS_technicalcriteria	Observable technical criteria such as functionality, costs, and efficiency.
5. STS_technology	The application of scientific knowledge for practical purposes or technical considerations.

2.4 Summary Theoretical Framework

Varying from the flexible MSF and multidisciplinary STS to the structured ACF, clear limitations of the above-mentioned frameworks include the inconsistent application of theoretical concepts as well as the challenge of identifying all factors that have the potential to influence the policy outcome. The factors that have been identified and translated into codes can be found in table 2.1, 2.2 and 2.3. Numerous factors that have been identified overlap with elements from the other frameworks. For example, there is a clear resemblance between policy entrepreneurs (MSF) and subsystems (ACF) as they both involve actors that intend to influence policy. Another example is the various ways in which the influence of events and/or shocks are accentuated. Whether talking about vivid examples (Hermwille, 2016), disruptions (Howlett and Cashore, 2009), focusing events (Kingdon, 1984) or external shocks (Sabatier, 1988), the literature review shows that such events may lead to different policy responses among countries (Morales et al., 2014). Akin to Kingdon's focusing events (MSF) and Sabatier's shocks (ACF), Baumgartner's and Jones' PET argues that long periods of policymaking stability, and policy continuity, can be disrupted by short but intense periods of instability and change. This also means that the disasters in Chernobyl and Fukushima as well as Germany's phase-out are likely to have had an influence on EU energy development. A scheme of the identified factors and elements and their suggested overlap can be found in appendix 9. Remarkably, all theories emphasize the eminent role of social factors that shape policy, including the public opinion, cultural perspectives, values and/or beliefs.

2.5 Sub-question 1.1

How can theories of policy change be used to explain and understand the position of NE in EU energy policy?

Policy change theories assert that there are many factors that have the potential to influence the policy process. Hence, elements from Kingdon's MSF, Sabatier's ACF as well as Sovacool's STS theory are used in the form of codes to detect indicators of policy change and provide theoretical explanations for the focus on NE in EU energy policy from 2006 to 2020. Looking at the three selected frameworks, focusing events (MSF) such as the German nuclear phase-out as well as the nuclear disasters are expected to codetermine the sensitive position of NE in EU energy policy. According to Baumgartner and Jones (1991) policy change can be incremental for decades, only to be followed by profound change, such as a shock, which sets an entirely new future direction for policy. Moreover, the influence of coalitions in the form of anti-nuclear lobbyists is expected to mitigate the focus on NE (ACF). Importantly, the challenge of limited yet necessary low-carbon alternatives to fossil fuels is at the heart of this research. Therefore, technical elements (STS) are expected to be omnipresent in order to find these alternatives. However, Kingdon (1984), Simon (1992) as well as Baumgartner's and Jones (1991) all recognize that policymaking is not per se a rational response. According to the punctuated equilibrium theory, decision-makers tend to process information in a parallel way through subsystems (ACF) and are subject to boundedly rational decision-making (Jones, et al., 2018; Baumgartner & Jones, 1991). This means that even if STS elements are expected to provide a more technological, thus rational, reasoning for the acceptance or rejection of NE as an alternative to fossil fuels in the common EU energy strategy, decision-makers cannot consider all issues at all times.

3. Methodology

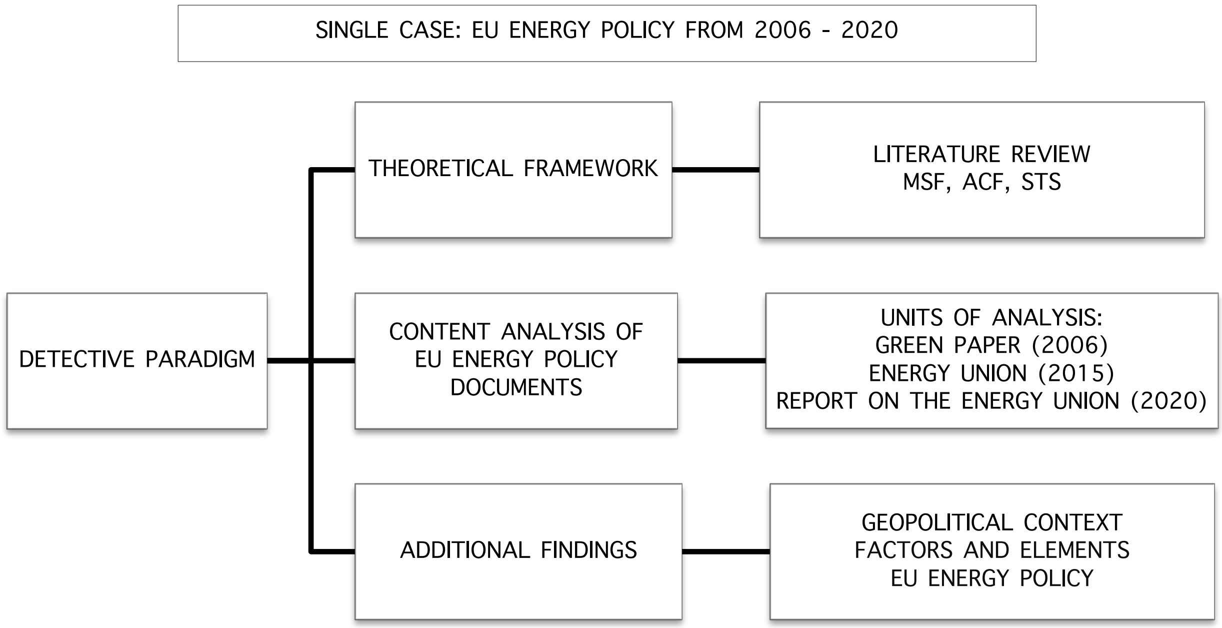
3.1 Research Design

The research method entails a single case (EU energy policy from 2006 to 2020) content analysis of respective EU energy policy documents (table 3). The content analysis builds further on the codes retrieved from the theoretical framework. By using insights from carious theoretical frameworks, a qualitative, exploratory and complementary approach of theory combination is applied (Cairney, 2013). Policy documents are commonly used to study policymaking at EU level, for example by Lange and Alexiandou (2010) to study policy learning on education, or by Brouwer et al. (2013) to examine developments in EU water policy. The nature of the research is exploratory as well as qualitative, whereas the modus operandi encompasses a detective paradigm that assembles all evidence in order to formulate evidence-based explanations for the focus on NE in EU energy policy. Importantly, this method does not necessarily produce causal relationships but brings the theoretical framework, results of the content analysis and additional findings together in a novel framework that exhibits plausible explanations. Above all, the research aims to add evidence-based insights on how the focus on nuclear energy in EU energy policy developed and provide possible explanations for this.

Table 3 – Units of Analysis

Case: EU energy policy 2006 - 2020		
Units of Analysis		**Year**
UoA 1	Green Paper - A European Strategy for Sustainable, Competitive and Secure Energy {SEC(2006) 317} (COM/2006/0105/final)	2006
UoA 2	Energy Union (REGULATION (EU) 2018/ 1999)	2018
UoA 3	2020 Report on the State of the Energy Union COM (2020)950	2020

Figure 2 – Research Design



Due to the qualitative nature of the research, the research method entails a content analysis. A content analysis is often recognized as one of the most famous techniques in order to understand social phenomena (Krippendorff, 2018). With respect to other qualitative research methods such as interviews or observation, the availability, accessibility and universality of the policy documents contributed to the choice of this research design. In addition, policy documents are considered an accurate representation of what is going on in EU energy policy. For example, if nuclear would have the same priority as any other energy source in EU energy policy, it would be likely to determine that based on the content of the selected policy documents. Moreover, the three selected policy documents analyse EU energy policy at three different moments in time to see how it evolved during this period. In terms of time and accessibility, it would also be unattainable to conduct interviews and talk to policy actors. Even if it was possible to reconstruct policy processes, it would be hardly possible to interview and/or observe the people who were involved or wrote the policy documents. Inherently, the content analysis represents the qualitative method to detect the presence of conditions and factors that have the potential to explain policy change according to the theoretical frameworks as it allows the researcher to quantify, label and analyse (parts of) texts. In other words, the aim of the content analysis is to present qualitative content in the form of objective and quantitative data. The elements that are present in the policy documents are expected to help in providing grounded theoretical explanations for the extent to which EU energy policy focuses on nuclear energy from 2006 to 2020.

Essentially, the content analysis is purely based on what could be extracted from the selected policy documents and is merely based on certain elements of the selected policy change theories, which in return produces confined and one-dimensional insights of what *de facto* is going on. Ergo, it is important to note that the elements extracted from the selected policy change theories do not guarantee the reading of all present factors involved in the development of EU energy policy. Furthermore, the concepts of the selected frameworks might be subject to wrongful interpretation and application. Nonetheless, together with the theoretical framework and supported by additional findings, a single case study content analysis is considered the most suitable method for this research.

3.2 Operationalization

The objective of this research design is to broaden the understanding of the focus on NE in EU energy policy by comparing, combining and supplementing various frameworks. The three selected theories presented in table 1 serve as the lenses through which the research is viewed and are used to read factors that contribute to the development of EU energy policy. In order to do so, the elements from each theory that are considered most relevant are operationalized (translated into codes) and used as indicators for policy change (table 4). To put it differently, the identified codes from the selected frameworks serve as indicators to detect whether and to what degree elements of policy change are present in the selected EU energy policy documents, to eventually determine the extent to which the focus on NE in EU energy policy evolved from 2006 to 2020. Thereupon, text fragments and excerpts from the units of analysis (UoA) on NE and other themes deemed relevant are studied and labelled (table 3). In this context, relevant sections include the ones dealing with nuclear energy as well as the sections that describe the main function of, reasoning behind, and common approach of EU energy policy. Irrelevant sections include lists of other regulations that are in line with the EU objectives, definitions of concepts, most annexes, role of third parties and/or some of the agreements and resources in place for reporting, among others. Notwithstanding the limitations of policy change theories and even if not the entire content of the policy documents is examined, this method is expected to provide additional insights on how EU energy policy evolved with a particular focus on nuclear energy. Furthermore, the outcome of the content analysis will help in answering sub-question 1.2 and 1.3 and eventually the central research question.

Table 4 - Codebook

Codebook	
Code	When to use
Multiple Stream Framework (MSF) John Kingdon's (2003/[1984])	
1. MSF_ambiguity	The ambiguity of actors and the importance of situational configurations that may influence the behavior of actors within the policymaking process
2. MSF_beliefs	The 'national mood' and the feedback they receive from interest groups and political parties.
3. MSF_focusingevent	External focusing events such as crises and accidents. Also called a focus event, triggering event, or "perturbations" existing outside an institutionalized policy subsystem, usually in the form of societal or political disruptions or learning. This kind of occurrence, typically exogenous, can make government decision-makers aware of the existence of a problem. A shift of attention may relate to a 'focusing event' or the sense that a well thought out solution already exists.
4. MSF_policyentrepreneur	Well-informed and well-connected insiders who provide the knowledge and tenacity to help couple the 'streams'. Actors known as 'policy entrepreneurs' develop solutions in anticipation of future problems, seeking the right time to exploit or encourage attention to their solution via a relevant problem ('solutions chasing problems').
5. MSF_policymakers	Policymakers have the motive, opportunity and authority to turn a solution into policy.
6. MSF_policystream	Policy instruments used to achieve goals.
7. MSF_policywindow	When the problem, policy, and political streams are coalescing.
8. MSF_politicsstream	Socio-political factors, including public opinions as well as organized political forces (coalitions) that shape policy
9. MSF_problemstream	When a problem is identified.
The Advocacy Coalition Framework (ACF) Sabatier (1988)	
10. ACF_authority	The governmental authority/power or ultimate decision-maker in a subsystem. 'Governmental authorities' may be formally responsible for policy decisions, but policymakers and influencers interact closely and may be members of advocacy coalitions.
11. ACF_action	Action takes place in subsystems, surrounded by a wider political system.
12. ACF_beliefsvalues	Policy core beliefs provide the glue to hold actors together, cooperate, and learn how to respond to new information and events and often to compete with other coalitions. Refers to the social structure and fundamental sociocultural values.

13. ACF_coalitions	More than one dominant actor. People with shared beliefs form coalitions. Coalitions influence how key actors understand, interpret and respond to external factors and/or events.
14. ACF_constitutional	Basic constitutional structure.
15. ACF_externalesources	Distribution of natural resources.
16. ACF_institutional	Type of institutions involved, also referring to various levels and types of government.
17. ACF_learning	Knowledge produced from outside the subsystem by an actor within the subsystem to inform policy change. Continuously adapt to new information about policy and their policymaking environment. Learning is a political activity, driven by actor's beliefs. People learn how to retain their coalition's strategic advantage and select or interpret the information they hold to be most relevant.
18. ACF_policy	A course or principle of action adopted or proposed by an actor or coalition.
19. ACF_policybrokers	The actors present within many (not all) subsystems that seek to minimize conflict and produce workable compromises between advocacy coalitions.
20. ACF_policyimpact	Measured/observed effects and/or results of a policy.
21. ACF_policyoutput	Sequence of related sets of variables; push and pull of several factors.
22. ACF_problem	Basic attributes of a problem area involving substantial goal conflicts, important technical disputes and multiple actors from several levels of government.
23. ACF_shocks	Shocks are the combination of external events and the reaction by coalitions. An occurrence such as the election of a new government with new ideas, or the effect of socio-economic change or "perturbations" existing outside an institutionalized policy subsystem, usually in the form of societal or political disruptions or learning. Events may prompt major change as members of a dominant coalition question their beliefs in the light of new evidence (external shock) or another coalition may adapt more readily to its new policy environment and exploit events to improve its position within the subsystem (internal shock). Internal and external 'shocks' affect the positions of coalitions within sub-systems.
24. ACF_strategy	A plan of action designed to achieve a long-term policy, belief or overall aim. A plan of action designed to achieve a long-term policy, belief or overall aim. The proposed way in which coalitions intend to achieve their goals, usually in the form long term plans/policies. Greatly varies per MS.
25. ACF_subsystems	When policy actors (subsystems), thus people, that engage in politics to translate their beliefs into policy and form coalitions.

26. ACF_subsystemresources	Means to achieve policy(s) (e.g., money, time, (access to) raw materials etc).
27. ACF_authority	The governmental authority/power or ultimate decision-maker in a subsystem. 'Governmental authorities' may be formally responsible for policy decisions, but policymakers and influencers interact closely and may be members of advocacy coalitions.
Science and Technology Studies (STS) Hess & Sovacool (2020)	
28. STS_science	Scientific knowledge or the systematic study of the structure and behaviour of the physical and natural world through observation and experiment.
29. STS_society	Social and cultural perspectives including networks, users, firms, states, social movements, social structure, race, class, gender, sexuality, national original, global position, values, cognitive categories, institutions, and so on. Grouping of humans.
30. STS_sociotechnical	Matters that are both social and technical. Also refers to the contested ways in which sociotechnical and material futures are imagined and strategically deployed.
31. STS_technicalcriteria	Observable technical criteria such as functionality, costs, and efficiency.
32. STS_technology	The application of scientific knowledge for practical purposes or technical considerations.

The research aims to identify a variety of conditions that have the potential to detect and explain the alleged shifts related to the focus on NE in EU energy policy. Each theory provides its own insights, main ideas and key indicators, on which a codebook is built as shown in table 4. With respect to the unidentified factors that might affect policy change and in view of the scope of the research project, only factors and elements (thus codes) that are deemed most relevant are used to explain the extent to which EU energy policy focused on nuclear energy from 2006 to 2020. Furthermore, a combination of a deductive and inductive methods is applied. The content analysis together with its codebook represent a deductive approach that helps in measuring theoretical concepts as it allows the researcher to test to what extent certain elements are present. Given that policy texts cover a multitude of dimensions, more than one code is applied to a single excerpt (simultaneous coding). Atlas.ti is used as software to analyse the selected policy documents by applying the above-mentioned frameworks through codes. Atlas.ti is a tool to conduct qualitative research as it allows the researcher to code texts systematically. Since the codes are designed and texts are labelled by the researcher, this method is sensitive to human error. In view of maximizing the validity of the research, the content analysis follows a consistent approach following specific coding rules.

Moreover, relevant sections will be crosschecked by a peer to enhance the overall reliability of the research (appendix 8). To strengthen the content validity, attributes of the variables are carefully considered based on the literature discussed in chapter 2, yet they are not designed to be mutually exclusive as elements from various theories are expected to (partially) overlap since the different frameworks deal with similar aspects as illustrated in appendix 9., there is also room for additional findings (inductive) that emerge during the research in view of providing the most credible and evidence-based explanations for the focus on NE in EU energy policy.

Finally, yet importantly, it is nearly impossible to identify and explain all elements involved in policy development based on the selected research design. In other words, the answers retrieved from this exploratory method are not expected to provide a fully-fledged answer to the central research question. Be that as it may, the policy documents in combination with the selected theoretical frameworks and additional findings are expected to expand the overall understanding of the extent to which EU energy policy focuses on nuclear energy. Altogether, this research design is considered the most feasible thus suitable approach to answer the research questions as complete and accurate as possible.

Table 5 – Coding Rules

CODING RULES	Firstly, the case (EU energy policy from 2006 to 2020) and UoA's (table 3) are selected for the content analysis. These consist of EU energy policy documents that are considered most relevant for answering the research questions.
	Secondly, the policy documents will be generally reviewed in order to single out sections that are considered relevant for the research.
	Thirdly, a codebook is developed (table 4) based on elements of the selected frameworks of table 1.
	Fourthly, the presence and frequency of the concept 'nuclear' will be determined for each UoA (table 3). Consequently, the extent and context in which it is mentioned will be discussed.
	Thereafter, the relevant sections of the UoA's are analysed, whereas excerpts are labelled using the codes of table 4.
	To strengthen the overall validity of the content analysis, sections that deal with nuclear energy will be crosschecked by a peer person (appendix 8).
	Finally, supplementary findings are collected throughout the research whereas a detective paradigm brings all findings together in a novel framework.

4. Results & Data Analysis

The results of the content analysis show that ACF is the most represented framework in the selected policy documents (table 6). To put it differently, the research shows that of the three selected frameworks, ACF is most adept at explaining how policy develops in the EU. The most commonly used codes are ‘ACF_coalitions’, ‘ACF_externalresources’ and ‘ACF_subsystems’ (table 7). Moreover, elements that are ought to overlap (appendix 9) are used in similar frequencies, which confirms similarities between elements of the selected frameworks (e.g., shocks and focusing events as well as values and beliefs).

Table 6 – Frequency Frameworks in Each UoA

	UoA 1 (Green Paper, 2006)	**UoA 2 (Energy Union, 2018)**	**UoA 3 (Report, 2020)**	**Total**
ACF	211	249	170	630
MSF	79	79	50	208
STS	48	67	50	165
Total	338	395	270	

Table 7 – Codes per UoA Ranked by Frequency

Codes	UoA 1	UoA 2	UoA 3	Total
1. ACF_coalitions	33	25	16	74
2. ACF_externalesources	27	21	17	65
3. ACF_subsystems	27	20	18	65
4. STS_technicalcriteria	13	24	17	54
5. ACF_strategy	25	21	8	54
6. ACF_policy	16	20	14	50
7. MSF_policystream	14	20	12	46
8. MSF_beliefs	16	18	10	44
9. ACF_subsystemresources	14	18	12	44
10. ACF_constitutional	13	18	11	42
11. ACF_institutional	12	13	13	38
12. ACF_problem	11	18	9	38
13. STS_sociotechnical	11	16	11	38
14. ACF_beliefsvalues	10	16	9	35
15. MSF_policymakers	16	10	7	33
16. ACF_action	13	11	8	32
17. STS_technology	10	14	11	25
18. MSF_policyentrepreneur	11	8	4	23
19. MSF_politicsstream	7	10	6	23
20. STS_society	7	9	6	22
21. ACF_authority	4	10	6	20
22. MSF_problemstream	7	6	5	18
23. STS_science	7	4	5	16
24. MSF_ambiguity	6	4	3	13
25. ACF_policyimpact	2	8	2	12
26. ACF_learning	1	5	5	11
27. MSF_focusingevent	2	3	3	8
28. ACF_policyoutput	1	1	6	8
29. ACF_shocks	2	3	3	8
30. ACF_policybrokers	0	0	1	1
31. MSF_policywindow	0	0	0	0

4.1 Sub-question 1.2

To what extent did the attention given to NE in EU energy policy evolve based on EU energy policy documents?

As demonstrated in table 8, the frequency in which NE is mentioned in each policy document varies between 1 time in 2018 and 15 times in 2020. Even if this does not say anything about the context in which it is placed, it is significantly less compared to other energy sources mentioned in the policy documents (table 9, 10 and figure 3). Hence, the results imply that there is little attention given to NE in the selected EU energy policy documents.

Table 8 – Presence and Frequency 'Nuclear'

Case: EU energy policy 2006 - 2020					
Units of Analysis		**Year**	**Pages**	**Hits**	**Frequency**
Document 1	Green Paper	2006	20	Yes	7
Document 2	Energy Union	2018	77	Yes	1
Document 3	Report on the State of the Energy Union	2020	24	Yes	15

Table 9 – Presence of Nuclear Energy Compared to Other Energy Sources

UoA 1		**UoA 2**		**UoA 3**	
Nuclear	5,9%	Nuclear	0,5%	Nuclear	11,9%
Fossil Fuels	67,2%	Fossil Fuels	43,5%	Fossil Fuels	49,2%
Renewables	26,9%	Renewables	56,0%	Renewables	38,9%

Figure 3 – Presence of Nuclear Energy Compared to Other Energy Sources

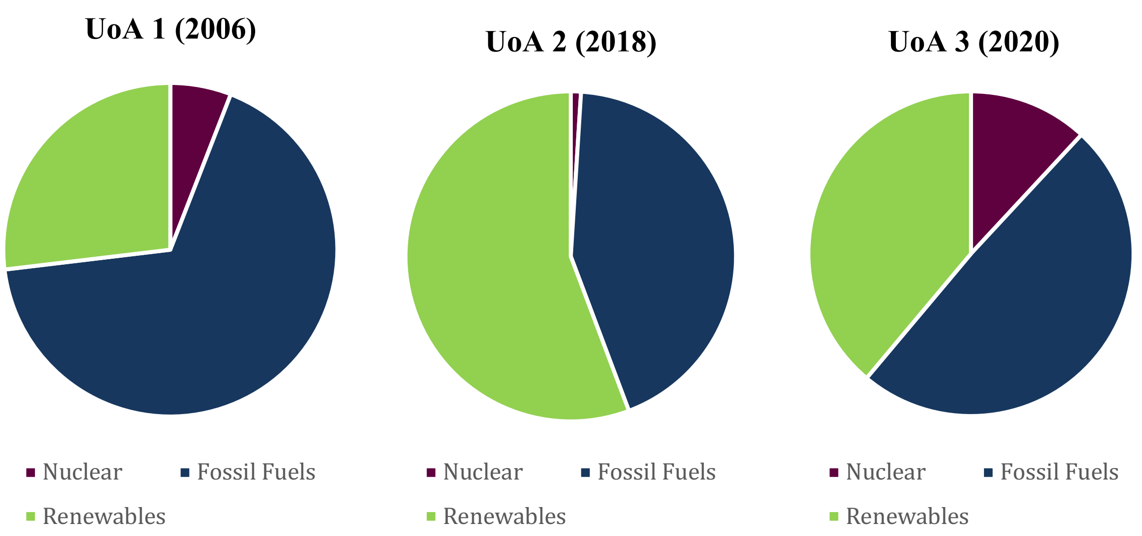


Table 10 – Frequency of Energy Sources Mentioned in UoA's

	Nuclear	**Fossil fuels**	**Renewable(s)**
UoA 1	7	80	32
UoA 2	1	140	182
UoA 3	15	62	49

Though the Energy Union (UoA 2) brings the energy policy and climate action together, it is remarkable that there is hardly any attention paid to nuclear power as one of the available means to achieve international climate goals as it is only mentioned once. On the other hand, this document was produced closest after the Fukushima incident. In the first UoA (Green Paper, 2006; thus pre-Fukushima), nuclear energy is generally referred to as a low-carbon energy source whereas the willingness to exploit the opportunities of "the future role of nuclear energy in the EU" is clearly expressed (p. 9). Moreover, the Green Paper (2006) already noted that "decisions by Member States relating to nuclear energy can also have very significant consequences on other MS in terms of the EU's dependence on imported fossil fuels and CO_2 emissions" (p. 9). At the same time, the Green Paper (2006) stresses the need for an overall strategic objective that would combine the freedom of MS to choose between different energy sources and the need for the EU to have an energy mix that meets its core energy objectives. In the Green Paper (2006) the core objectives are divided into six priority areas including security of supply, a more sustainable energy mix, an integrated approach to tackle climate change and a strategic European energy technology plan, among others. This raises the question whether there is much freedom to choose from while simultaneously meeting the objectives.

Whereas NE was more generally mentioned in the Green Paper (2006), nuclear energy was only mentioned once, in between brackets, as one of numerous energy sources in the second and largest UoA (Energy Union, 2018; thus, post-Fukushima). The attention paid to nuclear energy seems to be cautiously but minimally increasing in the third UoA (2020 Report on the State of the Energy Union) compared to the Energy Union (2018). In the 2020 Report on the State of the Energy Union, there are three brief paragraphs dedicated to nuclear safety and security and the cooperation with third countries. Interestingly enough, the position of NE in EU energy policy remains opaque during the period that spans 2006 to 2020. UoA 2 merely pays attention to it at all and UoA 1 and 3 almost exclusively focus on the more technical considerations of nuclear energy (STS). On the other hand, policy documents are not expected to discuss the public sentiment and corresponding social values. Per contra, other research has shown that policymakers do react and respond to expressions of the preferences and demands of the public (Morales et al., 2014). This also flows from the results of content analysis as MSF and ACF labels are more frequently used.

Despite the limited information on the attention given to NE in EU energy policy, the extent to which it receives attention does slightly seem to evolve, though almost negligible. In sum, nuclear energy seems to have a minor and rather ambiguous role in EU energy policy according to the policy documents. At the same time, this underlines the ongoing debate around NE and its minimal yet slightly shifting focus. It becomes clear that the deployment of nuclear energy was no subject to major changes in EU energy policy as it remained relatively stable and underexposed in all three policy documents covering the period from 2006 to 2020. All in all, the little attention paid to the deployment of NE in EU energy policy does uphold sensitivities around the subject.

4.2 Sub-question 1.3

How can the elements of policy change detected in the policy documents explain the involvement of nuclear energy?

As shown in table 7, the most present elements of policy change detected in the policy documents are coalitions, external resources, subsystems, technical criteria, strategy, policy and beliefs. Both 'ACF_coalitions' and 'ACF_subsystems' refer for example to each MS that chooses its own energy mix. In return, this choice has an impact on the energy security ('ACF_externalrecources)'. Example 1 shows an excerpt of the Green Paper (2006) where the above-mentioned codes were labelled.

Example 1 – Screenshot Atlat.TI Green Paper (2006, p. 9)

2.3. Tackling security and competitiveness of energy supply: towards a more sustainable, efficient and diverse energy mix

Each Member State and energy company chooses its own energy mix. However, choices made by one Member State inevitably have an impact on the energy security of its neighbours and of the Community as a whole, as well as on competitiveness and the environment. For example:

- decisions to rely largely or wholly on natural gas for power generation in any given Member State have significant effects on the security of supply of its neighbours in the event of a gas shortage;
- decisions by Member States relating to nuclear energy can also have very significant consequences on other Member States in terms of the EU's dependence on imported fossil fuels and CO_2 emissions.

Nonetheless, not all labelled codes are indicators for policy change. Even if some of the codes rank high in terms of frequency, they can oftentimes be excluded as actual factors that trigger policy change. Examples include 'ACF_policy' and 'MSF_policystream', given that policy documents discuss policies without necessarily indicating change or explaining the involvement of NE.

Other examples of frequent codes that can be excluded as catalysts for policy change are 'ACF_constitutional' and 'ACF_institutional'. Like policy codes, these codes simply label excerpts that name constitutional and institutional levels. On the contrary, 'MSF_focusingevent' as well as 'ACF_shocks' are among the least frequently used codes while they are proven to have a significant influence on policy outcomes (Morales et al., 2014; Jahn and Korolczuk, 2012). Therefore, it is important to note that although codes indicate factors that may be involved in policy development, the frequency in which they are used do not necessarily reflect their significance. Focusing events (MSF) are proven to shape values and beliefs, naturally resulting in conflicting coalitions (ACF) and consequently, in a marginal and ambiguous focus on nuclear power in EU energy policy. Remarkably, the codes 'beliefs and values' are mostly attached to the second UoA where nuclear energy is least present. This could indicate that less attention was paid to NE due to socio-political factors such as the public opinion. It is argued that internal as well as external shocks have the potential to lead to policy change, as they shape beliefs, values, trigger socio-political reactions and consequently: the public opinion (Sabatier, 1988; Yun, 2016). If external events have the potential to codetermine the position of NE in EU energy policy, the Fukushima incident is likely to have caused the observable decrease of attention paid to NE in the Energy Union (2018) compared to the Green Paper (2006). This means that policy change might also refer to the absence of NE. Given that shocks tend to be accompanied by the necessary controversy, policy change theories appear to suit contested issues.

Moreover, there are codes that are difficult if not impossible to detect thus label, such as 'MSF_policywindow' and 'ACF_policybrokers'. This could either mean that they are not present or that the researcher was unable to identify them. According to Kingdon's MSF, a policy window would be likely to open when the problem, policy, and political streams merge. In this context, the problem stream refers to the need for a low-carbon energy source that meets the growing energy demand together with the growing pressure to minimize GHG emissions and energy dependency, whereas the policy stream represents the Energy Union as a policy tool to achieve this. The politics stream refers to socio-political factors, including public opinions as well as organized political forces (coalitions) that shape policy. Even though Kingdon's three policy streams appeared to create a policy window with regards to a reconsidered focus on NE in EU energy policy, no clear evidence to support the presence of such policy window emerged from the content analysis. Moreover, it was hardly possible to identify policy brokers as they very specifically refer to actors within 'some' subsystems that seek to minimize conflict and produce workable compromises between advocacy coalitions. Given that the motivations of policy brokers are not explicitly expressed in policy documents, it was nearly impossible to identify policy brokers.

Although technical criteria were expected to play an increasingly important role in the energy mix and against the expectations discussed in chapter 2.5, elements from STS are least represented in the policy documents. Even if not rigidly represented through the content analysis, STS are often used for practical improvements and solutions within the energy field (e.g. smart grids and algorithms). This emphasizes that the frequency in which elements are detected do not necessarily reflect their overall significance. In the same vein, Jenkins-Smith and Sabatier (1994) emphasize the propensity for learning and the role of science and technology in the policy process. In any case, the detected STS elements in the policy documents do not provide adequate evidence to explain the limited focus on NE in EU energy policy.

Though there are still many concerns around nuclear safety and security, a constant progress in its development is being recorded (Kim et al., 2020). Moreover, there are no specific remarks on the risks of nuclear energy voiced in the policy documents. The voiced risks mainly relate to elements such as shocks, events and external resources, e.g.: "risks of import dependency and the physical security of Europe's energy infrastructure against risks from natural catastrophe and terrorist threat, as well as security against political risks including interruption of supply is critical to predictability" (Green Paper, 2006, p. 8). This underlines the geopolitical complexity of energy policy as it touches many areas. The Energy Union has a specific regulation on 'Risk Preparedness' in the electricity sector, which ensures that MS have tools to cooperate with each other in order to prevent, prepare for, and mitigate electricity crises. However, the text does not go into much more detail about the content of these risks much less about the role of NE. The 2020 Report on the State of the Energy Union mainly highlights the risks of MS not meeting their (renewable energy) targets. However, it does note that MS have prepared preventive action and emergency plans with regards to the security of gas supply. These contain measures for mitigating the impact of a gas supply disruption and risks identified at national and regional level. However, the possible role of NE in this is again not specified.

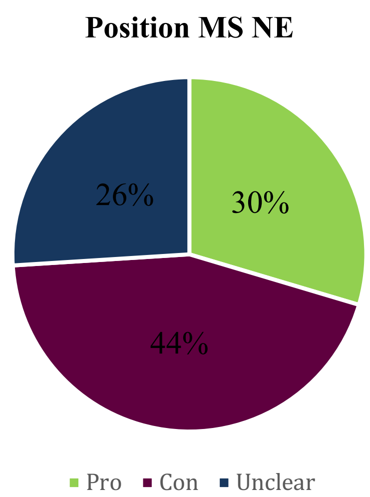
As mentioned in chapter 2, Kingdon claims that policy changes when new solutions are made more consistent with existing practices. Be that as it may, NE might not be considered a 'new' solution to an existing problem. New solutions would include a breakthrough in generating significantly more renewable energy or the development of any other environmentally friendly alternative to fossil fuels that meets the energy demand while reducing GHG emissions and energy dependency. Moreover, MS have their own policies and beliefs concerning the deployment of NE as demonstrated in table 11 and figure 4 (European Commission, 2021b). It is hardly possible to deduct public opinions from the policy documents alone. However, practise shows that there are subsystems and coalitions with contradicting beliefs and policy intentions.

A clear example of conflicting coalitions can be found in Sweden where the decision on where electricity should come from is splitting the Swedish parliament (Duxbury, 2021). In this regard, the minority government, consisting of the Social Democrats and Greens, do not consider nuclear energy as a clean and renewable energy source (ibid.). Sweden's largest opposition parties, the Moderate Party and the far-right Sweden Democrats on the other hand, define clean as "fossil free" and encourage nuclear power to be part of the energy mix (ibid.). This discussion culminates in a subdebate concerning nuclear's green recognition. Even if there is something to say for both sides, the expected influence of divided coalitions on policy outcomes is hereby affirmed, often resulting in opaque policies when it comes to nuclear power. Another example or policy paradox is the German phase-out vs. the constructions of nuclear power plants in e.g., Finland, France and Slovakia (World Nuclear Association, 2020). This means that nuclear power plants are removed from one country, only to be rebuilt in another one. Other examples of divided coalitions can be found in the undecided or reconsidering countries such as Italy and the Netherlands. Table 11 and figure 4 give a general overview of the positions of EU MS and their national attitude towards the deployment of nuclear energy, whereas appendix 4 contains a more detailed overview.

Table 11 - Position MS NE

Pro	8	29.6%
Con	12	44.4%
Unclear	7	26%
Total	27	100%

Figure 4 – Position MS NE



4.3 Hypothesis 1

H1 Even though there seems to be an increased need for low-carbon alternatives to fossil fuels, the focus on nuclear energy in EU energy policy documents is fading.

Though the attention paid to NE in EU energy policy documents is not linearly fading, it can be argued that the subject is underexposed compared to other alternatives to fossil fuels as shown in table 9, 10 and figure 3. The lack of attention is likely due to external events and the beliefs and values that flow from that. As an example, public opinion polls showed a growing acceptance of nuclear power before the accident in Fukushima in 2011 (Morales et al., 2014). After the Fukushima incident, several MS decided to change their nuclear policy. Germany remains a famous example since seven reactors were immediately shut down, before putting an end to the entire nuclear programme by 2022 (Morales et al., 2014; Jahn and Korolczuk, 2012). In 2011, the Italian government decided to withdrawal from their previous decision to revive the nuclear energy programme. The Italian nuclear programme ended in 1990, shortly after the nuclear disaster in Chernobyl in 1986 and after a series of referenda in 1987. Again, Italy seems to reconsider the use of nuclear energy as they do not rule out future deployment (World Nuclear News, 2021). At the EU level, the EC sharpened the safety rules and implemented safety stress tests in collaboration with the organizations that group the nuclear energy regulating agencies (ENSREG and WENRA). However, in several other European countries no policy changes took place. Thereupon and as discussed in chapter 2, the role of coalitions seems to be significant when it comes to the establishment of respective policies. Research shows that there are several factors that determine what gets political attention (again). Lucidly, the extent to which NE receives political attention, either positive or negative, varies greatly per MS (table 11, figure 4 and appendix 4). According to the International Atomic Energy Agency (2008), "Europeans' attitudes towards nuclear power and radioactive waste seem to depend on whether their countries have nuclear power plants or not". In this respect, the viability of NE as a carbon-friendly alternative to fossil fuels mainly seems to depend on the divergent approaches and beliefs of coalitions within MS. This lack of unity seems to have an influence on the general focus of NE in EU energy policy. Although the EC is tasked to promote the general interests of the EU and set a common strategy, this seems to be rather ambiguous when it comes to the specific policy instruments in place to safeguard the common goods and achieve international objectives. In the same vein, "the EC has recognized that binding national targets for renewables do not fit well with a single EU market, and that the cross-border effects of capacity mechanisms create problems" (World Nuclear Association, 2021). Again, paradoxical policies of MS seem to annihilate each other. In conclusion, research shows that the focus on NE in EU energy policy has been steadily underexposed rather than fading or abating.

4.4 Hypothesis 2

H2 The fact that there are insufficient other alternatives for low-carbon energy resources that meet the EU's energy demand is not considered in EU energy policy.

Even if EU energy policy pays attention to research and the development of carbon-friendly alternatives to fossil fuels, there is no other concrete solution expressed to bridge the remaining energy demand without the use of fossil fuels besides the further development of RES. In this context, the EP (2021) acknowledges various challenges posed by the increasing share of renewables. Be that as it may, the research does not provide significant evidence to claim that there are no other low-carbon energy alternatives considered in achieving the EU's objectives. In this regard, Saidi and Omri (2020) suggest a mix of nuclear and renewable energy as a feasible option to reduce CO_2 emissions as the two sources of energy are argued to be perfectly complementary. The question remains whether there are alternative energy sources to be considered that can meet the EU's energy demand while reducing GHG emissions and energy dependency.

4.5 The Detective Paradigm

The detective paradigm collects and weighs evidence in order to formulate, and rule out, the most plausible explanations for the limited yet slightly shifting extent to which EU energy policy focuses on NE during the period that spans 2006 to 2020. Even if the presence of elements detected in the policy documents alone do not necessarily indicate policy change, the detective paradigm encompasses the most present theoretical elements that appear to shape EU energy policy as well as preceding focusing events and shocks in the geopolitical context (Kingdon, 1984; Sabatier, 1988). Research shows that at least some factors that influence policy outcomes can be identified. Therefore, the detective paradigm builds further upon the strong involvement of policy actors such as coalitions and subsystems in the form of MS or other forms of organized political forces. Essentially, policymaking is a political struggle over values and ideas. As Stone (2002) aptly describes, paradoxes underlie seemingly straightforward policy decisions, whereas politics cannot be cleansed from the process in favour of "rationality." At the same time, this explains why expectations do not always come true. Even the most plausible explanations (e.g. elements of STS that were expected to provide substantial technical and rational reasonings for the acceptance or rejection of NE as an alternative to fossil fuels in the common EU energy strategy) are subject to bounded rationality. Simon's (1990) theory on bounded rationality suggests that decision-makers are subject to cognitive limitations in making choices and finding the optimal choice falls or stands with the availability of information at a specific moment in time. This means that policy actors pushing for a particular policy cannot consider all problems and their solutions, meaning that rationality is limited when individuals make decisions.

In addition, Simon (1990) argues that decisions also depend on the specific moment in time. A clear example is the demarcated tasks of ministers, as they can only pay attention to matters for which they are responsible, whereas other matters get prioritized or ignored. Even if energy security is a priority area for most policymakers, climate change might not be. For many, climate change is not considered a top priority as its incremental rather than an abrupt change (Baumgartner & Jones, 1991; European Council for an Energy Efficient Economy, 2020). In addition to the difficulty for least developed countries (LDC) to prioritize a low-carbon energy mix, the European Council for Energy Efficient Economy (2020) stresses that in wealthy countries, relatively few people feel directly affected by climate threats. Even if nuclear power covers more than not emitting CO_2, it affirms the decisive role of policy actors such as coalitions and subsystems (ACF). Remarkably, the policy documents do not discuss the costs of developing nuclear capacity, yet it is of importance as there are clear budgetary differences between EU MS. Since the research has identified a number of factors that have the potential to indicate policy change, this novel framework replaced the so-called black box by a blue box that represents the geopolitical context, thus the environment in which policies are formed (figure 5). The geopolitical context exhibits both periods of stability as well as disruptions of short but intense periods of instability and change (Baumgartner & Jones, 1991). Akin to the garbage can model, the identified factors that have the potential to influence policy development swerve in the orange circle, whereas the eventual product is the policy itself. To put it differently, the attention paid to nuclear energy depends on various political, social as well as technical complexities and sensitivities that are inextricably linked to the focus on NE. The context in terms of time, events, policy actors and the available information all play an important role in the formulation of policies. In sum, the establishment of policies can be complicated and opaque.

Figure 5 – Illustration of a Novel Framework

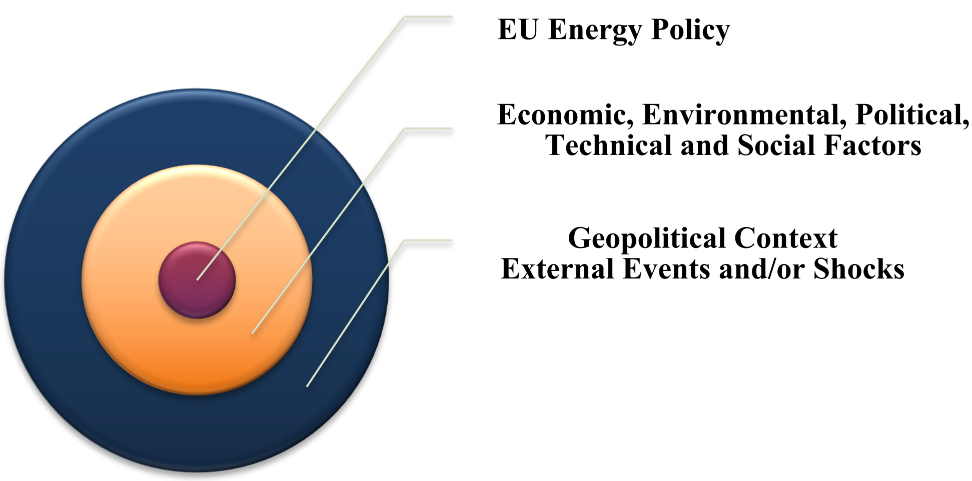


Table 12 – Detective Paradigm

DETECTIVE PARADIGM	
	Geopolitical Context The geopolitical context is influenced by geographical factors and refers to the entire environment in which policies are formed. In other words, it embraces all factors that are involved in the establishment of respective policies. Many of the challenges in the field of energy take place in the geopolitical context. Geopolitics include events or shocks, e.g. the Fukushima accident, that shape factors such as the social structure and values and beliefs that flow for it. It also refers to other matters including the distribution of external resources, climate change, energy demand and dependency as well as international conflicts and the divergent approaches of EU MS that complicate a common EU energy policy. In sum, geopolitical complexities, such as international conflicts, policy paradoxes, climate goals, energy demand and dependency appear to play a significant role in the development of EU energy policy.
	Factors and elements that influence policy The second layer refers to the specific economic, environmental, political, technical as well as social factors and elements extracted from the policy change theories that are argued to influence EU energy policy. According to the content analysis, the most dominant elements that are present in policy documents are coalitions, external resources, subsystems, technical criteria and beliefs/values. Evidently, policy change can come forth from various elements that flow from the preceding chain of events. An example includes values and beliefs of policy actors in the form of coalitions and the public opinion. According to Sabatier (1988), policy core beliefs provide the glue to hold actors together, cooperate, and learn how to respond to new information and events (thus to the geopolitical context). These socio-political factors, including the values and beliefs of the public opinion as well as organized political forces (coalitions) shape policy as policymakers tend to react and respond to expressions of the public.
	EU Energy Policy The actual EU energy policy represents the outcome of all the above-mentioned factors. In this respect, the Energy Union represents a specific example of a policy instrument that aims to decarbonize the EU economy, ensure energy security, diversify Europe's energy sources, create a fully integrated internal energy market, improve energy efficiency, reduce dependency on energy imports, drive jobs and growth as well as support breakthroughs in low-carbon and clean energy technologies (European Commission, 2020d). The geopolitical context of this policy is driven by climate change, energy demand and dependency whereas the aims of the Energy Union are based on economic, environmental, political, technical and social considerations.

It is important to note that the identified elements are interconnected. The challenges for the EU energy system principally take place in a geopolitical context. The EP (2021) summarizes energy challenges as follows: "increasing import dependency, limited diversification, high and volatile energy prices, growing global energy demand, security risks affecting producing and transit countries, the growing threats of climate change, decarbonisation, slow progress in energy efficiency, challenges posed by the increasing share of renewables, and the need for increased transparency, further integration and interconnection in energy markets."

5. Discussion

Numerous weaknesses of the research already came to the surface throughout the research. One of the foremost vulnerabilities entails the limited information that can be deducted from the policy documents. Hence, it might be better to look at MS or countries specifically rather than EU policy documents when examining policy change in relation to contested issues such as nuclear energy. Another indisputable weakness of the research is the lack of clarity and analytical precision of theoretical concepts. Moreover, there may be factors that influence the policy process but are not extracted from the research, thus overlooked. Both the validity and reliability of the research cannot be fully guaranteed. Whereas the reliability refers to the consistency of the measures and the extent to which results can be reproduced when repeated under the same conditions, the validity of the research refers to the accuracy of a measure, thus the extent to which the results measure what they are supposed to. A large part of the conducted research depends on the interpretation of the researcher, which weakens the overall validity. This also refers to the sections of the UoA's that are picked for the coding and the ability of the researcher to understand and consider all codes equally while analysing the text. However, this bias is minimized by crosschecking certain sections of the UoA to confirm whether the codes attached to the policy documents flow logically from the theory. The crosscheck found that 85% of the labelled codes in the selected sections matched, whereas all the same codes where applied. However, the researcher attached more, mostly overlapping, codes to the same sections, which is most likely due to the familiarity with the topic (specific results of the crosscheck can be found in appendix 8). Eminently, the reliability of the research can also not be fully guaranteed as the extent to which EU energy policy focuses on nuclear energy is multi-interpretable rather than fixed. In addition, there might be factors present that have not been identified or labelled throughout the research. In other words, the complexity and multitude of dimensions of policy change theories come at the expense of the overall reliability of the research. However, the reliability is strengthened by considering a time span of more than 10 years and by establishing specific coding rules. Moreover, inductive findings contribute to provide the most complete results possible. This means that supplementary evidence builds further upon the results of the content analysis to reinforce more accurate inferences and conclusions. If the research would be reproduced for the same time period and based on the same UoA's using the same coding schemes, similar results and conclusions are expected to arise. Finally, it is important to consider that this research strongly depends on interpretation as well as the specific moment in time in which it is conducted. With respect to the limitations of this research, the research intends to maximize the overall validity as well as reliability by means of a carefully selected research method, collecting and considering evidence in an objective manner.

Although the selected research method intends to capture all necessary factors and facilitate accurate measurements, theories on the policy process remain rather abstract and apply differently across policy areas. Furthermore, qualitative data analysis mistakes and coding errors cannot be fully eliminated due to the human nature of researcher, yet it is minimized to the best extent possible. With respect to the complexities of EU energy policy, it is important to consider that climate action is a dynamic if not wicked problem in a constantly changing geopolitical context. In the same vein, factors that influence policy development are subject to constant change, reminiscent of the debate on nuclear energy. In sum, this research project attempts to provide evidence-based explanations for the meager role of nuclear energy in EU energy policy development by combining and adding insights to existing scientific knowledge. At the same time, the gap between the extent to which EU energy policy focuses on nuclear and scientific explanations for this reflect the scientific relevance of the research project.

6. Conclusion

There is little focus on NE in the selected EU energy policy documents ranging from 2006 to 2020, particularly compared to the attention paid to other energy sources. Moreover, the focus on NE in EU energy policy hardly evolved during this period as little attention was paid to it in the first place. The exploratory research found that this can be explained by means of numerous factors that have the potential to influence policy, such as shocks or events that lead to conflicting beliefs. Notwithstanding the value of MSF and STS, the results of the content analysis showed that ACF is the most suitable framework for this domain. This is mainly because of the strong role of coalitions and subsystems in policymaking. Even if not all elements of policy change can be detected, the three selected frameworks provide fruitful handles in giving possible explanations for the limited attention paid to NE in EU energy policy. The theoretical framework shows that socio-political factors including the public opinion as well as organized political forces (coalitions and/or subsystems) flow from the geopolitical context and shape policy as policymakers tend to react and respond to the expressions of the public. However, the theoretical framework in combination with the content analysis alone does not provide sufficient evidence to explain the de facto involvement of NE in EU energy policy. Hence, the research strategy requires a detective paradigm that combines the theoretical framework and the results of the content with additional findings. Additional findings included the divided sentiment among EU MS and were particularly in the sphere of geopolitical complexities, such as international conflicts of interest, climate goals, energy demand and dependency. In addition to RES and besides NE, there does not seem to be an apparent other feasible low-carbon alternative on the table that could meet the remaining energy demand. Previous research suggests that nuclear and renewable energy sources are complementary, whereas a mix is argued to be the best option in reducing GHG emissions. However, MS still have the ‘power’ to follow their own path and decide upon their own energy mix. There is no denial that there are contradicting convictions and beliefs with regards to the deployment of nuclear power. With respect to contradicting beliefs, there do not seem to be many other options than increasing nuclear’s share in the energy mix if the EU wishes to accomplish its ambitious objectives on a short term. Thus far, the EU seems inclined to keep its hands off this contested issue. For this reason, future research that dives deeper into ACF for countries specific as well as the degree to which the principle of subsidiarity upholds is strongly encouraged. Moreover, the alternatives for low-carbon energy sources that can meet the EU’s energy demand are to be further explored. At any rate, the debate around nuclear energy does not seem to come to an end any time soon, especially since the sentiment among the MS is greatly divided. Looking at the policy documents as well as the divergent national approaches, there is no consistent focus on nuclear energy.

Even more so, the fact that there is little focus on NE in EU energy policy does give the impression that policymakers are not too keen on actively promoting it as a favoured alternative to fossil fuels. All things considered, EU energy policy does not seem to point all noses in the same direction, which poses a serious challenge if international climate goals, energy demand and energy independence is to be met. As long as MS remain fully autonomous in this area and national beliefs, interests and approaches prevail, a common EU energy policy does not seem to have the desired effect.

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52669416#:~:text=Russia%20is%20not%20a%20member,an%20ally%20to%20the%20group.&t

ext=The%2014%20OPEC%20countries%20had,about%201.5%25%20of%20world%20production

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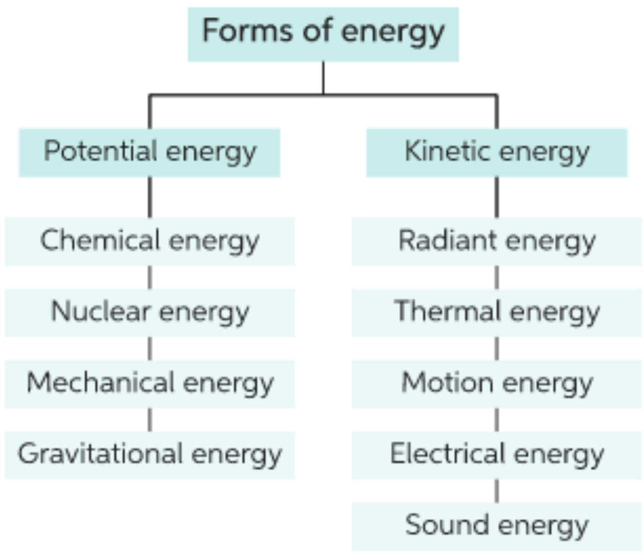
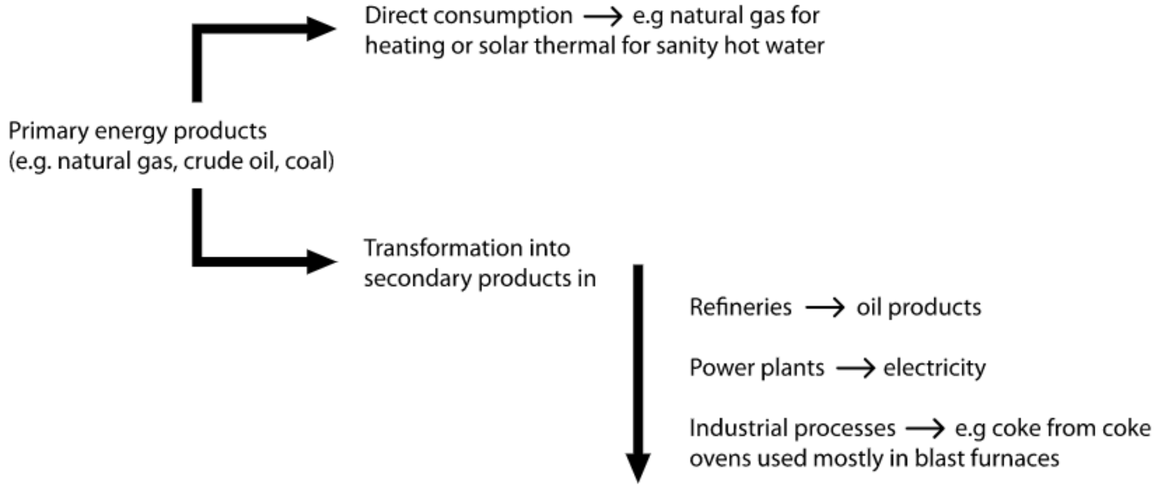
8. Appendices

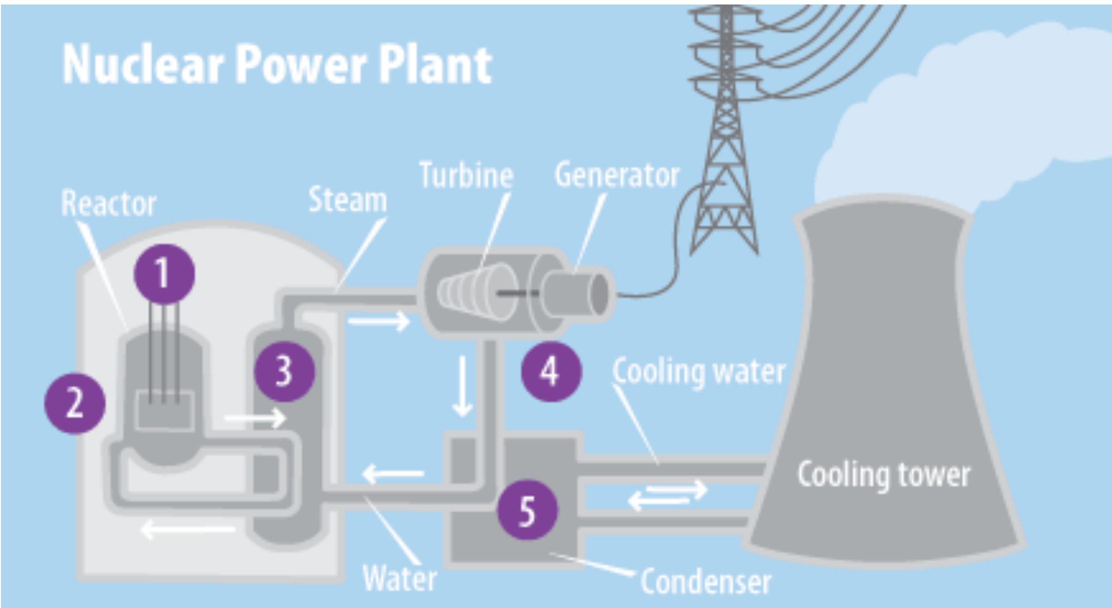
Appendix 1 - Forms of Energy



Appendix 2 - Flow of Energy from Production to Final Consumption



Appendix 3 - Simplistic Overview of How Nuclear Energy Works



1. In a nuclear reactor, fuel rods full of uranium pellets are placed in water.
2. Inside the fuel rods, uranium atoms, such as uranium-235, split apart when neutrons hit them and release energy.
3. This energy heats water, creating steam.
4. The steam moves through a turbine, which turns a generator to create electricity.
5. The steam cools back into water, which can then be used again. At some nuclear power plants, extra heat is released from a cooling tower.

Nuclear waste refers to:

- the leftovers when the reactor is done running
- fission products (when done using the fuel)
- structural materials nearby that have absorbed some of the neutrons and become radioactive
- and/or anything else radioactive

* Radioactivity can damage cells, DNA and eventually cause cancer.

* Nuclear waste can be properly contained to avoid any chance of radiation exposure to people, or any pollution.

(Nuclear Energy Institute, 2020).

Appendix 4 - EU MS & NE

Nuclear power in select European countries

Country	Nuclear power generation capacity (MW)	Stance on nuclear and policy outlook
Belgium	5,918	Closure of all plants by 2025 subject to supply certainty.
Finland	2,764	Key part of energy strategy. One new 1,600-MW plant awaiting commissioning.
France	61,370	Key part of energy strategy. Closure of oldest plants, construction of new 1,650-MW reactor.
Germany	8,113	Closure of all plants by 2022.
Spain	7,121	Closure of all plants planned by 2035.
United Kingdom	8,923	Nuclear as baseload power source. One new 3,200-MW plant under construction.

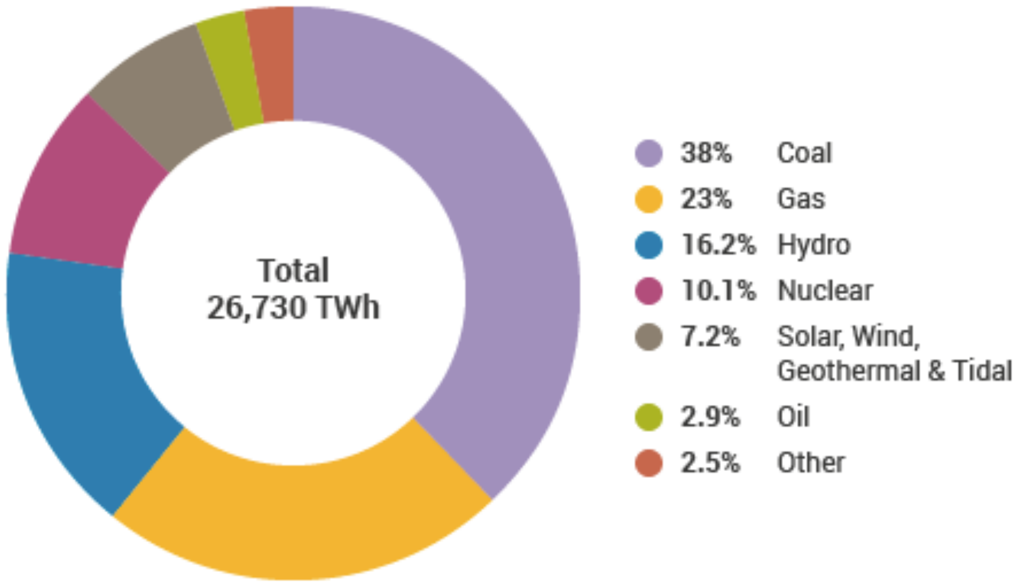
Data compiled on April 13, 2021.
Capacity data as of September 2020.
Sources: Foratom; S&P Global Market Intelligence analysis

EU MS		Position	Nuclear reactor(s) 2020	% of total electricity generated from nuclear 2020	Concrete Examples/Policy
1.	Austria	Con			The Austrian parliament unanimously passed the Constitutional Law on a Nuclear-free Austria in 1999. Austria does not support nuclear energy and focuses on the development of RES.
2.	Belgium	Con	X	39.1	Nuclear energy covers a large part of electricity demand, while the government plans to phase out nuclear between 2022 and 2025.
3.	Bulgaria	Pro	X	40.8	Reactor planned.
4.	Croatia	Pro			Co-owns nuclear power plant with Slovenia.
5.	Cyprus	Con			There are no nuclear power plants, no research reactors, no radioactive waste management facilities, no manufacturing of radioactive sources or devices and no uranium mining and milling activities.
6.	Czech Republic	Pro	X	37.3	Reactor planned.
7.	Denmark	Con		3-4%	There are no nuclear power plants in Denmark. Denmark imports but does not produce nuclear energy. In 1985, the Danish parliament passed a resolution that nuclear power plants

					would not be built and there is currently no move to reverse this situation.
8.	Estonia	Unclear			Estonia has no nuclear power plants, research facilities or facilities for radioactive material production. The Estonian government formally approved the formation of a nuclear energy working group (NEPIO) tasked with analyzing the possibility of introducing nuclear energy in Estonia.
9.	Finland	Pro	X	33.9	Reactor under construction and reactor planned.
10	France	Pro	X	70.6	Largest share of nuclear in the EU, also seen as the pioneers of nuclear energy as France went full nuclear after the oil crisis in 1973. Reactor under construction.
11	Germany	Con	X	11.3	Nuclear phase-out planned for 2022.
12	Greece	Con			Although Greece has established the Greek Atomic Energy Commission, the decision is made not to implement a nuclear power program to generate electricity. In Greece, there are no nuclear power plants and nuclear energy is not considered as an option in the foreseeable future.
13	Hungary	Pro	X	48	Two reactors planned.
14	Ireland	Con			There are no nuclear power plants, research reactors or waste facilities. Ireland does not, and has never, produced any electricity from nuclear power stations. The Irish government is also not considering nuclear power for a role in the future energy system.
15	Italy	Unclear			Italy shut the last two reactors down after the Chernobyl accident. Italy is the only G8 country without its own nuclear power plants. The government intended to have 25% of electricity supplied by nuclear power by 2030, but this prospect was

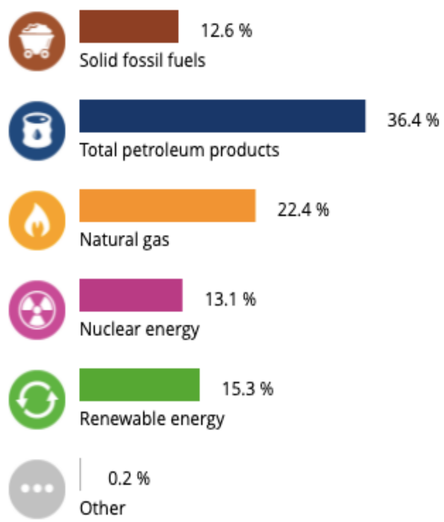
					rejected at a referendum in 2011. Though future use of nuclear is not completely ruled out, there are no concrete nuclear future plans.
16	Latvia	Con			Latvia has no nuclear power plants and does not intend to build one.
17	Lithuania	Unclear			Two reactors proposed.
18	Luxembourg	Con		-	Luxembourg has no nuclear power plants and or other nuclear installations. Luxembourg's political parties, just like the German government, reject nuclear energy completely.
19	Malta	Con		1.5 (2014)	There are no nuclear power plants or research reactors.
20	The Netherlands	Unclear	X	3.2	A previous decision to phase out nuclear power was reversed.
21	Poland	Unclear		0	Poland plans to have nuclear power from about 2033 as part of a diverse energy portfolio, moving it away from heavy dependence on coal. In this regard, six reactors are proposed.
22	Portugal	Con		8 (2015)	Portugal does not have a nuclear power programme. Portugal has one research reactor which is in permanent shutdown state. Nuclear energy in Portugal is very limited and strictly non-commercial.
23	Romania	Pro	X	18	Government support for nuclear energy is strong. Two operating reactors and two reactors planned.
24	Slovakia	Pro	X	53.1	Reactor under construction and reactor proposed.
25	Slovenia	Unclear	X	37.8	Reactor proposed.
26	Spain	Con	X	22.2	Spain also has a nuclear phase-out planned. Four reactors are scheduled to close by the end of 2030, the remaining three reactors will shut down by 2035.
27	Sweden	Unclear	X	29.8	Sweden's utilities have upgraded three plants.

Appendix 5 - World Electricity Production by Source 2018



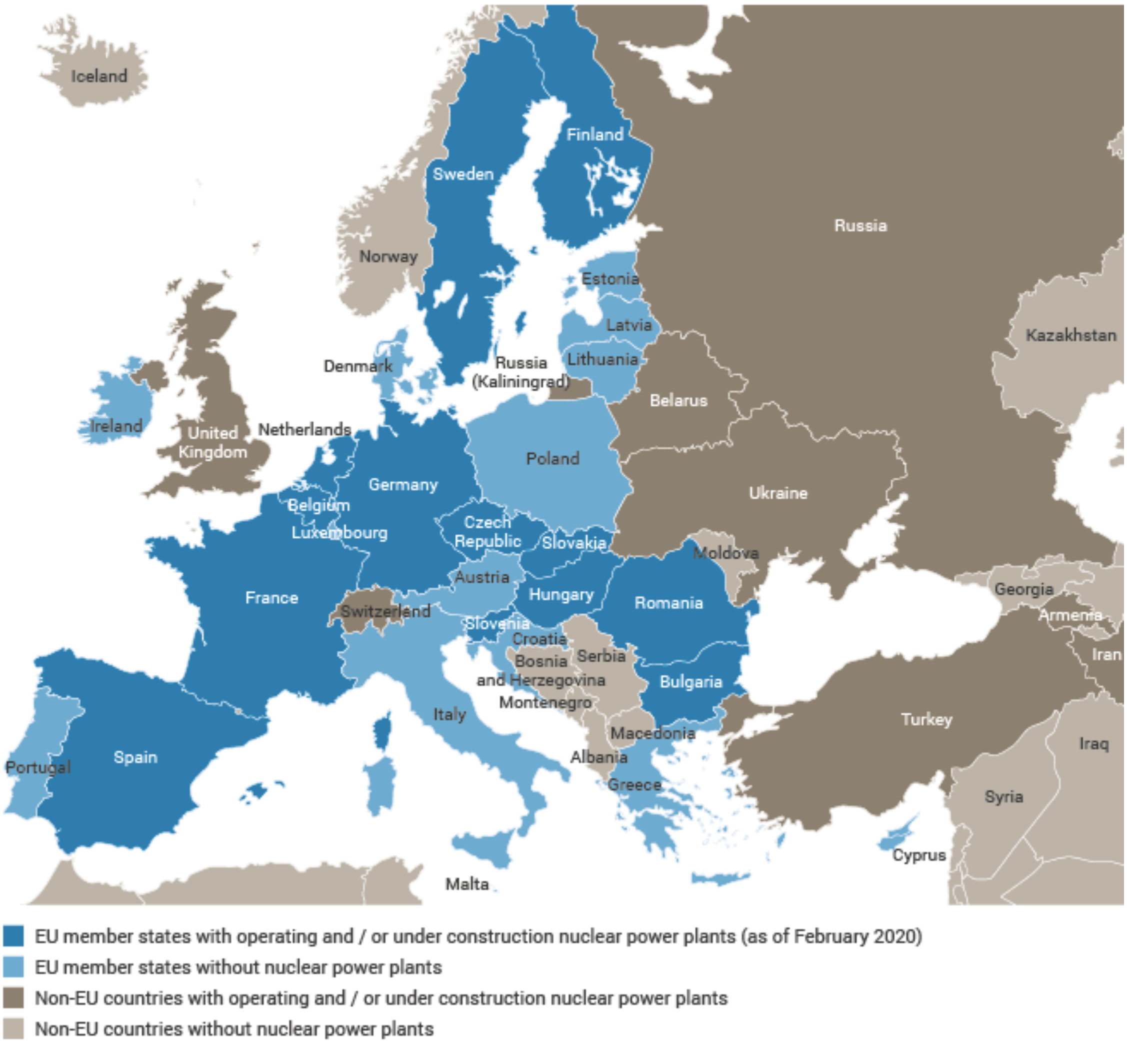
(International Energy Agency, 2018)

Appendix 6 - EU Energy Mix 2019



(Eurostat, 2021)

Appendix 7 - Power Plants in the EU 2020

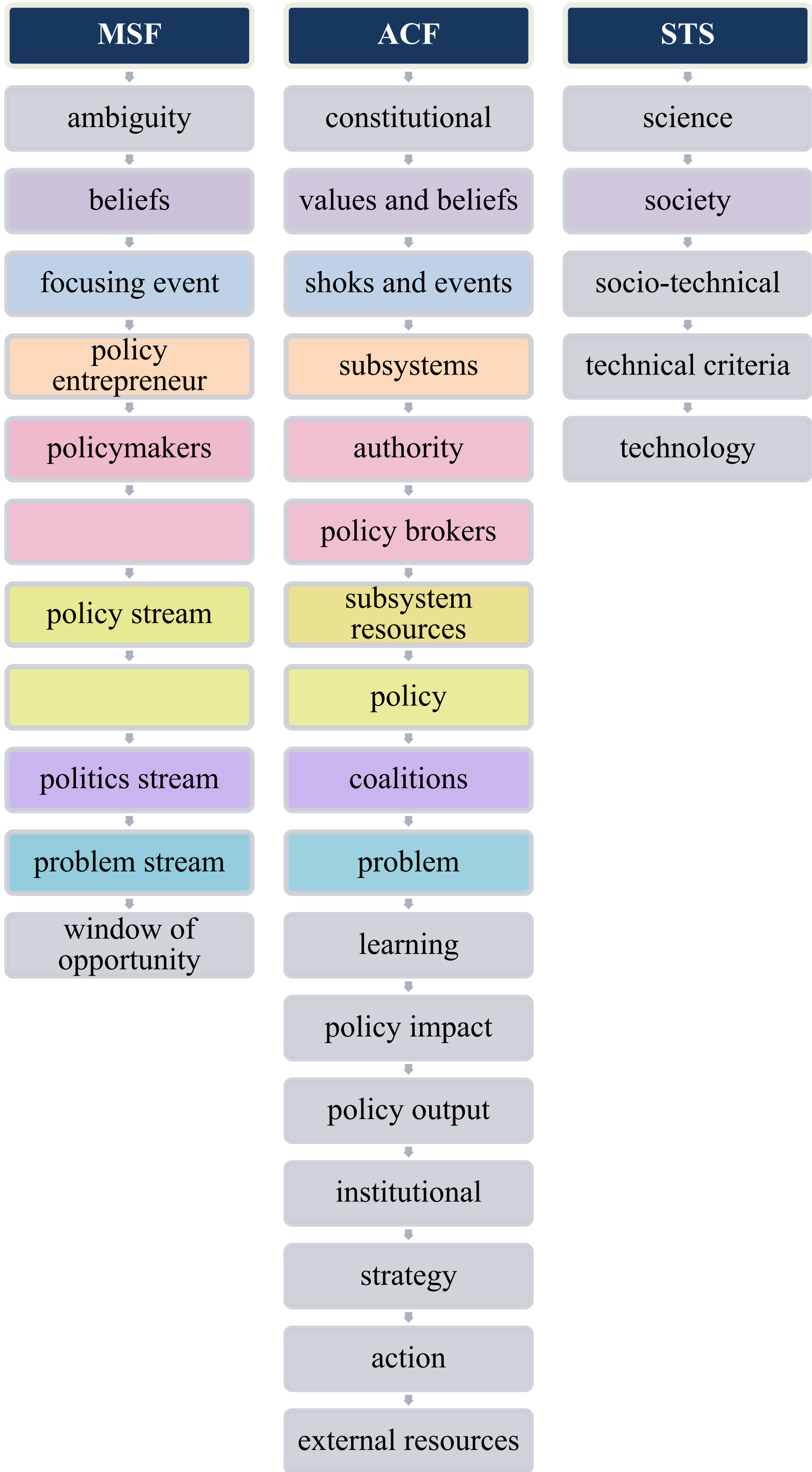


(World Nuclear Association, 2021)

Appendix 8 - Results Crosscheck Content Analysis

UoA	Section (page)	Match	Difference
UoA 1	p. 9	88%	Researcher used additional codes
UoA 2	p. 55	76%	Researcher used additional codes
UoA 3	p. 8	91%	Researcher used additional codes
Average match of 85%			

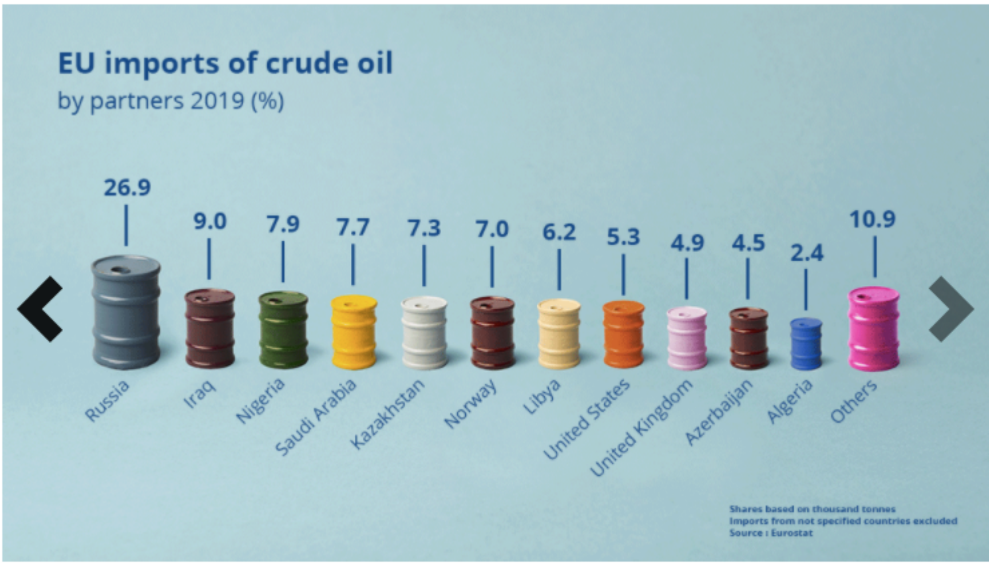
Appendix 9 - Coding Scheme

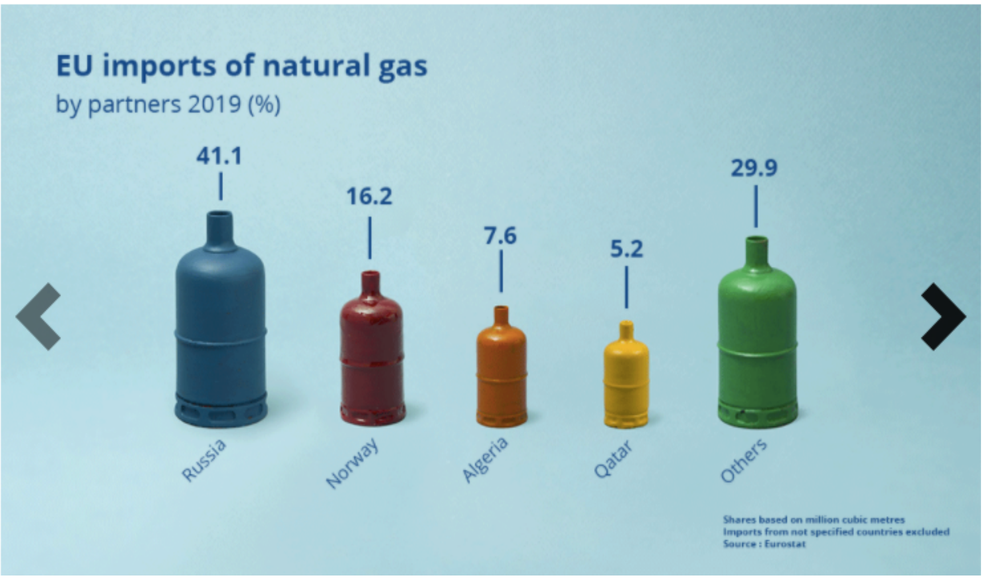


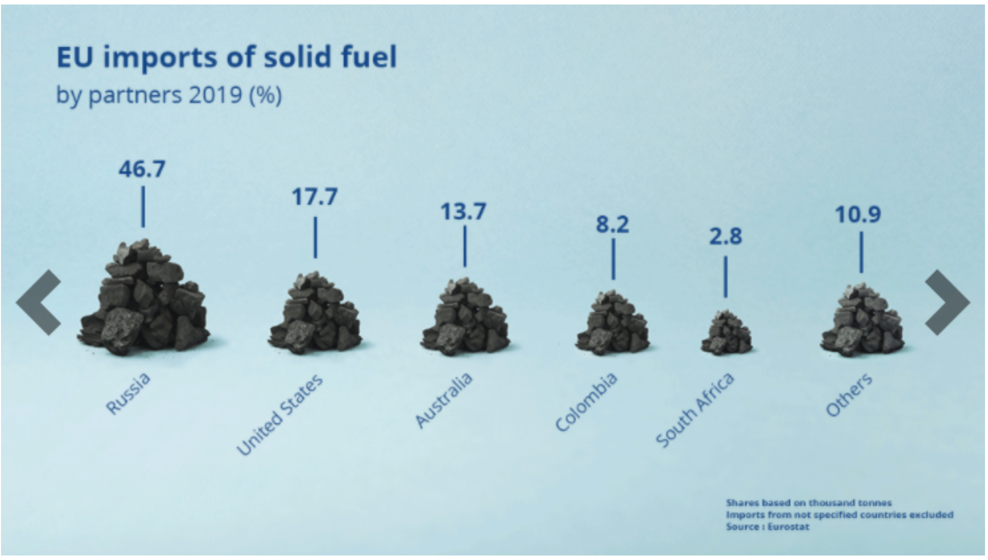
Appendix 10 - OPEC Member Countries

1. Algeria (1969)
2. Angola (2007)
3. Congo (2018)
4. Equatorial Guinea (2017)
5. Gabon (1975)
6. Iran (1960)
7. Iraq (1960)
8. Kuwait (1960)
9. Libya (1962)
10. Nigeria (1971)
11. Saudi Arabia (1960)
12. United Arab Emirates (1967)
13. Venezuela (1960)

Appendix 11 - EU Imports of Crude Oil, Natural Gas and Solid Fuels





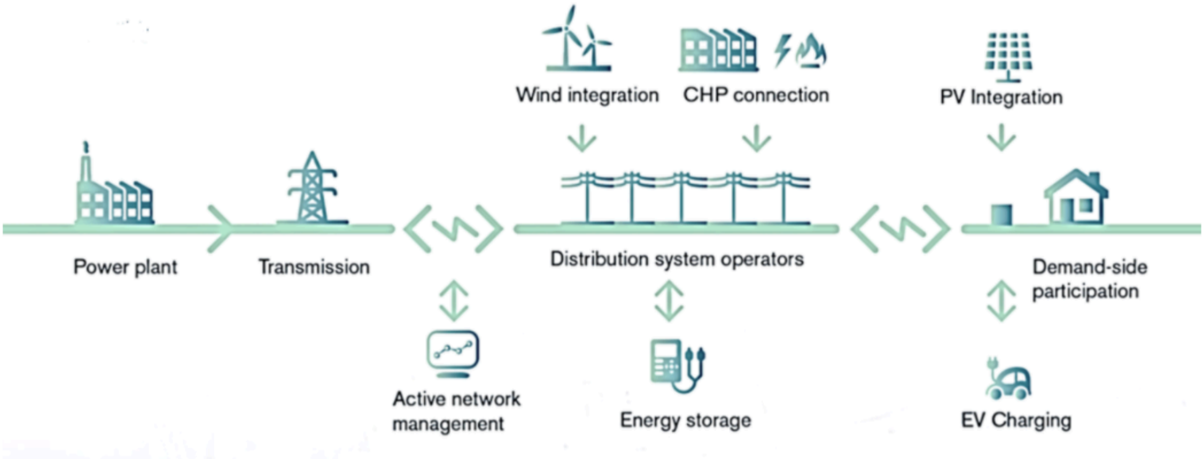


(Eurostat, 2020)

Appendix 12 - Traditional vs. Smart Grid

Before

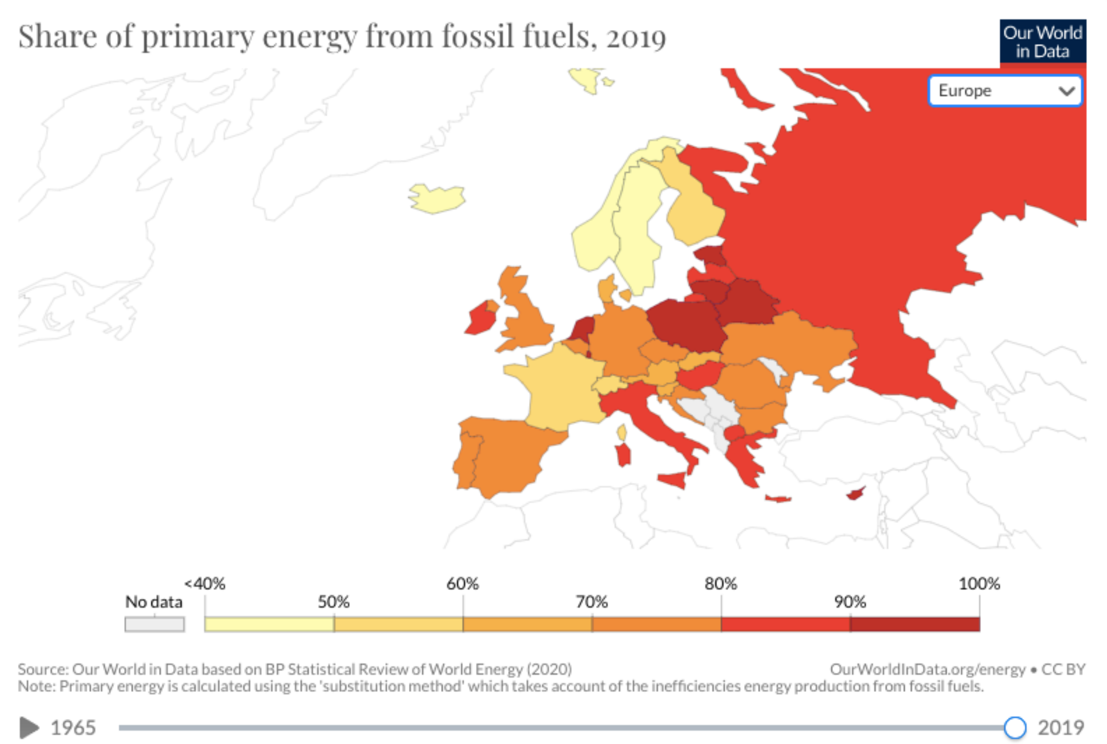
After

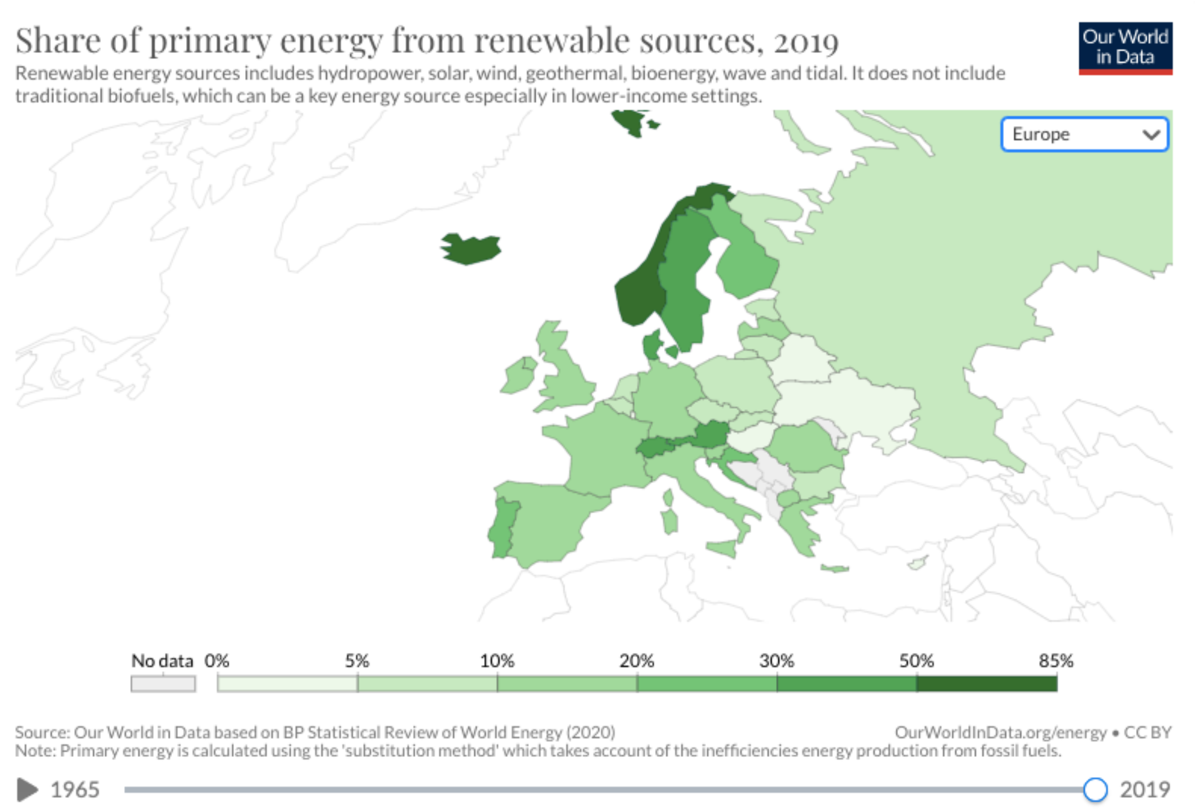


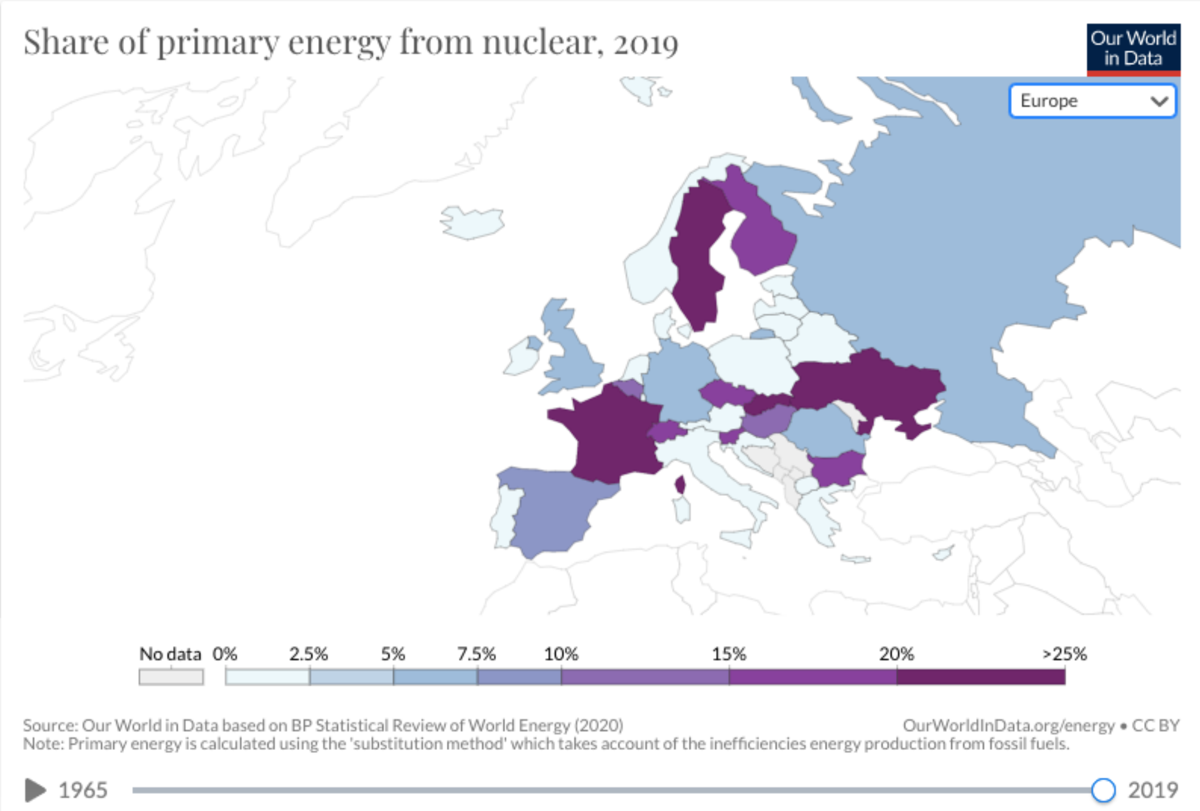
(European Distribution System Operators, 2021)

There are more than 36 power grid managers (DSOs) in 27 EU countries. Their networks handle around 3,000 TWh of power each year. The electric power transmission grids (overhead and underground high-voltage power lines) of each European country are managed by either one or several operators: RTE in France; TenneT, Amprion and Elia in Germany; Elia in Belgium; TenneT in the Netherlands; Terna in Italy; National Grid in the United Kingdom; and REE in Spain. (Planete Energies, 2016).

Appendix 13 - Share of Energy by Source Europe 2019






Share of primary energy from nuclear, 2019
Our World in Data
Europe
No data
0%
2.5%
5%
7.5%
10%
15%
20%
>25%
Source: Our World in Data based on BP Statistical Review of World Energy (2020)
OurWorldInData.org/energy • CC BY
Note: Primary energy is calculated using the 'substitution method' which takes account of the inefficiencies energy production from fossil fuels.
1965
2019