FACULTY OF SCIENCE AND TECHNOLOGY

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Preface and Acknowledgement

It is with immense pleasure and a deep sense of gratitude that we present this thesis, titled "Revision and Discussion of the Energy Situation (Crisis) in Europe from a Risk Perspective: The United Kingdom and Germany Cases." This work represents the culmination of our joint efforts and academic journey in the field of risk management. Throughout the process of conducting this research, we have sought to shed light on the complex energy challenges faced by Europe, with a particular focus on the United Kingdom and Germany.

Undertaking this research would not have been possible without the support and guidance of numerous individuals, whom we would like to acknowledge with heartfelt appreciation. Primarily, we express our deepest gratitude to God Almighty for granting us the strength, wisdom, and perseverance to embark on this academic endeavour.

We are indebted to our families and friends for their unwavering encouragement, understanding, and patience throughout this journey. Their constant support and belief in our abilities have been instrumental in keeping our spirits high and pushing us to achieve our goals.

We extend our sincere appreciation to the faculty of Science and Technology at the University of Stavanger, Norway, for providing us with a nurturing academic environment and the necessary resources to pursue our research. We would like to express our profound gratitude to our thesis supervisor, Andreas Falck; the Senior Principal Engineer at DNV and Associate Professor II at the University of Stavanger, Norway; whose invaluable guidance, expertise, and constructive feedback have been instrumental in shaping this work.

We also wish to acknowledge the contribution of the professors and lecturers at the Risk Management Department, who have imparted their knowledge and expertise, equipping us with

the necessary tools and skills to undertake this research. Their dedication to teaching and mentorship has been crucial in our intellectual development.

Furthermore, we are grateful to the professionals, experts, and individuals who generously shared their insights, perspectives, and time during the data collection phase of this study. Their valuable contributions have enriched our research and provided us with a comprehensive understanding of the energy situation in Europe.

Lastly, we would like to extend our appreciation to all those who may not be mentioned explicitly but have played a role, whether big or small, in supporting us throughout this thesis. We are thankful for your contributions and your positive impact on our academic journey.

With humility and a deep sense of fulfilment, we present this thesis, hoping that it may contribute to the field of risk management and serve as a foundation for future research endeavours. May this work foster meaningful discussions, inspire innovative solutions, and contribute to a more sustainable and secure energy future for Europe and beyond.

Eduardo Galue Campos & Jonah Obinna Nwachukwu

Abstract

The energy crisis has been a topic of great concern for the global community. It is characterized by the volatility of energy prices, the increasing demand for energy, and the need to reduce greenhouse gas emissions. Europe has been facing an energy crisis that has threatened the region's economic stability and security. Energy security is a critical issue for the European Union, as it is highly dependent on imported energy resources. According to the European Commission, around 53% of energy consumption in the EU is imported, with the dependency expected to rise to 73% by 2030 (European Commission, 2018). The United Kingdom and Germany are among the largest energy consumers in Europe, and their energy policies and energy mix have significant implications for the region's energy security. This thesis, titled "Revision and Discussion of the Energy Situation (Crisis) in Europe from a Risk Perspective: United Kingdom and Germany Cases," delves into the energy challenges faced by Europe, with a particular focus on the United Kingdom and Germany. The study through the definition of five research questions delves into the strategies the UK and Germany have been using to manage the current energy crisis. Authors choose a qualitative methodology approach through the scoping of different publications such as papers, books, reports, National Regulatory Authorities (NRAs), and government crisis management plans. Theoretical basis are presented on the Risk Management and Governance domain which is later compared to the theoretical findings on the risk and crisis management practices the European Union, the United Kingdom and Germany have implemented or are currently effective. The analysis section them present the results and expand on each country specific cases. The United Kingdom's energy policy is shaped by its commitment to reducing greenhouse gas emissions and its desire to maintain energy security. The country's energy mix comprises natural gas, oil, coal, nuclear, and renewable energy sources. Germany's energy policy is also shaped by its commitment to reduce greenhouse gas emissions and it is facing challenges meeting its energy demand. The country has set ambitious targets for renewable energy, and it has closed all its nuclear power plants. However, the transition to a low-carbon energy system has also increased Germany's reliance on imported energy resources, raising concerns about the country's energy security. As part of the conclusions, some points are discussed as follow: The UK and Germany have developed toolboxes which provides key definitions, methodologies, suggestions, and examples on how to carry risk assessments. These documents are based on the EU regulations as part of treaties signed among all the countries participating in the commission. European countries in general seems to agree that all risk assessment and management methodologies as per EU commission recommendations should be based in ISO 31010. This is the case also for the UK where the BIS (British institute of Standardisation) agrees in the same. As a general conclusion this study present that even though national risk assessments and plan have been in place, some of the analysis lacked on the resilience and the likelihood of the risk events to occur.

Keywords: Energy crisis, Energy security, risk management, crisis management, UK energy crisis, Germany energy crisis, national risk assessment, risk governance.

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List of abbreviations

BIS	British Institute of Standardisation
CSDP	Common Security and Defence Policy
DE	Deutschland
EU	European Union
ESO	UK National Grid Electricity System Operator
GICS	Global industry classification standard
GB	Great Britain
GCEE	German Council of Economic Experts
GK	General knowledge
ISO	International Organization for Standardization
JBI	Joanna Briggs Institute
NRA	National Risk Assessments
NUPI	Norwegian Institute of international affairs
RA	Risk Assessment
RM	Risk Management
SRA	Society for Risk Analysis
SK	Strength of knowledge
SAPEA	Science Advice for Policy by European Academies
SoS	Security of Supply

1. Introduction

1.1. Introduction

The energy crisis has been a topic of great concern for the global community. It is characterized by the volatility of energy prices, the increasing demand for energy, and the need to reduce greenhouse gas emissions. Europe, being one of the major energy consumers in the world, has been facing an energy crisis that has threatened the region's economic stability and security.

Energy security is a critical issue for the European Union, as it is highly dependent on imported energy resources. According to the European Commission, around 53% of energy consumption in the EU is imported, with the dependency expected to rise to 73% by 2030 (European Commission, 2018). This reliance on imported energy makes the EU vulnerable to price shocks and supply disruptions, which can have a significant impact on the region's economy.

The United Kingdom and Germany are among the largest energy consumers in Europe, and their energy policies and energy mix have significant implications for the region's energy security.

The United Kingdom's energy policy is shaped by its commitment to reducing greenhouse gas emissions and its desire to maintain energy security. The country's energy mix comprises natural gas, oil, coal, nuclear, and renewable energy sources. However, the United Kingdom has been facing challenges in meeting its energy demands due to the closure of ageing power plants, the decline of domestic gas production, and increases energy demand (National Grid Electricity System Operator, 2020). Additionally, the uncertainty surrounding Brexit has raised concerns about the country's energy security and its access to the European energy market.

Germany's energy policy is also shaped by its commitment to reduce greenhouse gas emissions and it is facing challenges meeting its energy demand. The country has set ambitious

targets for renewable energy, and it has closed all its nuclear power plants. However, the transition to a low-carbon energy system has also increased Germany's reliance on imported energy resources, raising concerns about the country's energy security.

In this thesis, we aim to analyse the energy situation in Europe from a risk perspective, focusing on the cases of the United Kingdom and Germany and their risk management strategies. We will examine the factors that have contributed to the energy crisis in Europe, and we will discuss the potential risks and challenges that the region faces in the future. We will also explore the different risk management strategies that are being used by the UK and Germany to mitigate the risks associated with the energy crisis.

This thesis it is compose by five chapter and the conclusions which are presented as follow: chapter 1 serves as an introduction, highlighting the research questions addressed in this study. These questions explore the various risk strategies employed by both countries, examine similarities between their approaches, and classify the recent energy crisis from a risk perspective. The chapter also outlines the research's scope and limitations, encompassing studies conducted up to mid-2023. In chapter 2, common scientific research methods are discussed, and the specific methodological approach employed in this study is presented. The chapter elucidates the data collection process and provides insights into the qualitative research method used.

Furthermore, chapter 3 lays the theoretical foundation for the thesis by discussing risk, risk management, and risk governance frameworks. Additionally, it explores the energy industry concept, encompassing distinct types of energies considered within this context. Chapter 4 delves into the risk and crisis management practices implemented in the European Union and their influence on the United Kingdom, Germany, and the region. This chapter serves as an introduction

to Chapter 5, where the theoretical basis and findings are merged to answer the research questions and analyse the energy crisis in the UK and Germany from a risk perspective.

In the conclusions, the authors present a comprehensive analysis of the current energy crises in the UK and Germany. This analysis involved a meticulous review of various sources, including papers, books, reports, National Regulatory Authorities (NRAs), and government crisis management plans, as discussed in the preceding chapters.

We believe that this thesis will make a significant contribution to the understanding of the energy crisis in Europe. Our research will provide valuable insights into the factors that have contributed to the crisis, and it will identify the potential risks and challenges that the region faces in the future. We will also explore the different risk management strategies that are being used by the UK and Germany, and we will discuss the potential benefits and drawbacks of these strategies.

We hope that our research will help to inform the development of more effective energy policies and risk management strategies in Europe.

1.2. Research questions

This study aims to answer the following investigation questions:

- What risk strategies have been used by the UK (United Kingdom) to manage the current energy crisis?
- What risk strategies have been used by Germany to manage the current energy crisis?
- What similarities or differences can be identified in the risk strategies adopted by each country?
- How does the EU influence the risk strategies implemented in both countries?
- How could the recent energy crisis be classified from a risk perspective?

1.3. Scope and limitations

Scope

This thesis examines the energy crisis in Europe through the lens of risk management, with a particular focus on its impact on the United Kingdom and Germany. The study explores the factors that have contributed to the energy crisis in these countries and the measures/risk management strategies each country implemented to enhance their energy security policies and mitigate the risks associated with the energy crisis.

The study draws on a range of sources, including papers, articles, official government, institutional reports, and previous studies with similar scopes.

Limitations

This study has a few limitations. First, it is a snapshot in time, and it does not attempt to predict the future course of the energy crisis in Europe. Second, the study focuses on two countries, the UK and Germany, and it does not consider the situation in other European countries. Third, the study does not consider the impact of the energy crisis on other sectors of the economy, such as manufacturing and transportation.

Despite these limitations, this study provides a valuable overview of the energy crisis in Europe, and it identifies several key risk management strategies that can be used to mitigate the risks associated with the crisis. The investigation and writing related to this thesis are limited to the first half of the year 2023.

2. Methodological approach

This chapter discusses briefly the common scientific methods for conducting research and presents the methodological approach employed in this study. It also explains how data was collected and provides a walkthrough of the methodological process employed to scope the data.

2.1. Research Method

Research methods can be defined as "a method, tool or technique the researcher uses in performing the research project" (Kothari, 2004, p. 3). Creswell (2014) provides a more comprehensive definition, stating that research methods are "the plans and the procedures of the research that span the steps from broad assumptions to detailed methods of data collection, analysis, and interpretation" (p. 5).

There are three main methods or approaches to conducting research: qualitative methods, quantitative methods, and mixed methods. The approach that a researcher chooses will depend on the characteristics of the required data to solve the research problem.

Qualitative research is defined as "the study of the nature of phenomena," including "their quality, different manifestations, the context in which they appear or the perspectives from which they can be perceived" (Busetto et al., 2020, p. 1). A more pragmatic rule of thumb to complement this formal definition is that qualitative research includes data in the form of words rather than numbers. For this thesis, a qualitative research method was used.

2.2. Research design

As discussed above, this study employed a qualitative research approach. Therefore, this section will be limited to qualitative research designs. Research design is defined by

Churchill and Brown (2004) as *"The framework or plan for a study that guides the collection an analysis of the data".*

Preparing research designs is a crucial step to ensure that the research is conducted efficiently and within the scope of the research questions. There are four common approaches to research descriptive, correlational, experimental, and diagnostic designs (Churchill and Brown 2004; Kothari 2004).

This study builds on existing theories and therefore applies a descriptive research design. According to Churchill and Brown (2004), descriptive design *"emphasizes determining the frequency which with something occurs, or the extent to which two variables covary"*.

As descriptive research aims to describe the current state of the research phenomenon it relies on accurate data. Qualitative research is also characterized by flexibility, openness, and responsiveness to context. Therefore, the steps of data collection and analysis are not as separate and consecutive as they tend to be in quantitative research. Fossey et al. (2002) put it as follows:

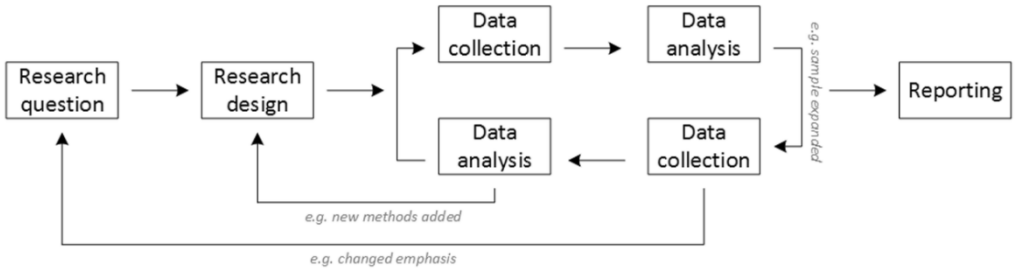
> *Sampling, data collection, analysis and interpretation are related to each other in a cyclical (iterative) manner, rather than following one after another in a stepwise approach.*

Moreover, the researcher can make educated decisions about the choice of method, how they are implemented, and to which and how many units they are applied (Hak, 2007).

As shown in Fig. 1, this iterative process can involve several back-and-forth steps between data collection and analysis where new insights and experiences can lead to adaption and expansion of the original plan. The process ends when saturation is achieved, i.e., when no relevant new information can be found. For reasons of transparency, it is essential for all decisions as well as the underlying reasoning to be well-documented.

Figure 1

Iterative research process



Note: Source, Busetto et al (2020)

Based on the above, the authors choose to follow a methodological framework based on a scoping review of publications, papers, and books. Scoping reviews are a type of literature review that aims to map rapidly the key concepts underpinning a research area and the main sources and types of evidence available. They can be undertaken as stand-alone projects, especially where an area is complex or has not been reviewed comprehensively before (Mays et al., 2001), which is the case of the energy crises.

The extent to which a scoping study seeks to provide in-depth coverage of available literature depends on the purpose of the review itself. From the most common reason to perform scoping reviews, this study will investigate, summarize, and disseminate other research, publications, and literature findings.

Scoping review methods have been initially proposed by Arksey and O'Malley (2005) and further advanced by Levac et al. (2010) and the Joanna Briggs Institute (JBI) (2015).

For the application of the thesis, it was chosen to follow the framework presented by Arksey and O'Malley (2005) which include the following stages:

- Stage # 1: Identifying the research question.
- Stage # 2: Identifying relevant studies.

- Stage # 3: Study selection.
- Stage # 4: Charting the data.
- Stage # 5: Collating, summarizing, and reporting the results.

2.3. Scoping Framework implementation

This section presents the results obtained after the implementation of the scoping review framework:

Stage # 1: Identify the research question:

The first step consisted of determining the research questions. Authors choose these questions based on the topic extension and the diversity of the sources, energy mix and general complexity. Authors aimed to cover the main points in line with general research objectives.

As presented in section 1.2, the research questions are:

- What risk strategies have been used by the UK (United Kingdom) to manage the current energy crisis?
- What risk strategies have been used by Germany to manage the current energy crisis?
- What similarities or differences can be identified in the risk strategies adopted by each country?
- How does the EU influence the risk strategies implemented in both countries?
- How can the recent energy crisis be classified from a risk perspective?

Stage # 2: Identify relevant studies:

The main search of primary literature identified a wide range of studies, papers, and the most recent crisis management plans developed by DE, the UK, and the EU. To achieve this, we adopted a strategy that involved searching for research evidence via diverse sources:

- Electronic databases,

- Reference lists,
- Key journals and information from the governments and energy regulatory agencies,
- Relevant organizations such as the official channels for the EU.

The papers are dated between 2009 and 2023. A total of 95 publications were collected. Table # 1 shows some of the search engines and keywords used to find the literature for the thesis.

Table 1

Search engines and keywords used for the literature search.

Search engines:	Search - keywords:
scholar.google.com	Energy crisis
google.com	Risk management
oria.no	Risk assessment
sciencedirect.com	Energy crisis EU
academic.research.microsoft.com	EU crisis management
getcited.org	Germany energy crisis
scienceresearch.com	UK energy crisis
	EU energy plan
	Energy security
	Energy sector

Note: Source, Galue and Obinna (2023)

Stage # 3: Study selection:

For the study selection, the authors design the following inclusion and exclusion criteria:

- Stage one: Title selection, to include all potential documents.
- Filter #1 - Abstract review: inclusion of documents after abstract revision.
- Filter #2 - Content skim and scanning: inclusion of documents after scanning the full content.
- Filter #3 - Complete content review: final stage to read all the content.

The initial perusal of the citations indicated that the search strategy had picked up a substantial number of irrelevant studies (95). The initial inclusion criteria involved looking for documentation that was closely related to the topics needed to answer our research questions judging by the title. In this sense, the following key factors were primarily targeted: type of study; type of intervention, study objectives, and territory coverage.

Following the initial criteria, three filters were applied as presented above as follow:

- Filter #1 - Abstract review
- Filter #2 - Content skim and scanning
- Filter #3- Complete content review

Copies of the full articles were obtained for those studies that appeared to represent a "best fit." If the relevance of a study was unclear from the abstract, then the full article was analysed. A deadline was set, after which it was agreed that we would not include any more studies in the analysis. The final stage requires reviewers to read the full articles to make the final decision about whether they should be chosen for inclusion in the agreed list of papers.

Quality appraisal:

For quality control, a full review of forty documents was done and this allowed us to eliminate an additional eight papers from the selection, making thirty-two the final number of publications to be used in our findings, discussions, and conclusions. See Figure 1 for a graphical explanation of the inclusion-exclusion process.

Results:

Thirty-two documents were included in the final list, classified as fit for purpose.

Stage # 4: Charting the data:

See Table # 6 as part of Appendix 1

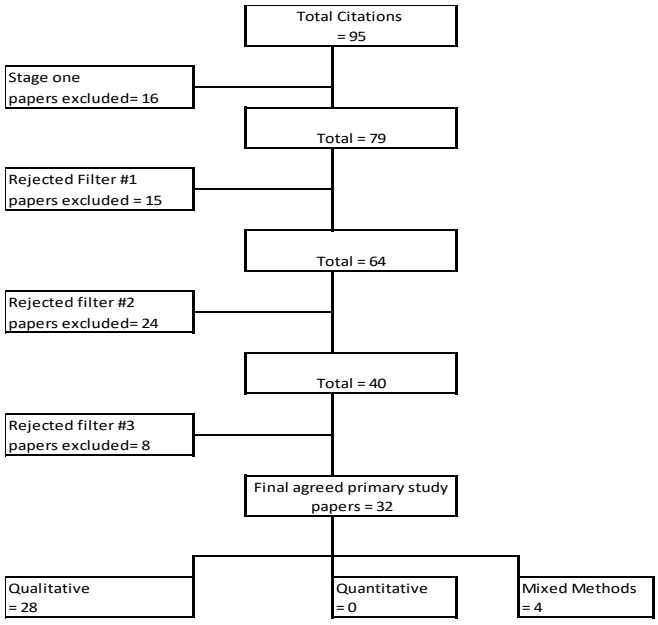
Stage # 5: Collating, summarizing, and reporting the results:

The in-deep review of all the papers, documents and publications selected as part of the scooping process allowed the authors to categorize the information into four focus areas:

- Risk assessment as part of the UK energy crisis management strategy.
- Risk assessment as part of Germany energy crisis management strategy.
- Risk assessment and crisis management framework from the EU.
- Macro concept of energy security

Figure 2

Flow chart of systematic review results.



Note: Source, Galue and Obinna (2023)

3. Theoretical Basis

This section introduces the theoretical basis for this thesis. First, a recompilation of risk, risk management and risk governance frameworks. Secondly a theoretical review of what it is understood as Energy industry and the types of energies it considers.

3.1. Risk concept and description

Aven & Thekdi (2021) in their book risk science described risks as having two important components, consequences, and uncertainties. They described risks as an activity with potentials for both undesirable consequences and desirable outcomes and uncertainties associated with these outcomes.

For the energy sector, there are several negative consequences such as

1. Energy rationing (Paltsev, 2005), which is because of lack of supply or disruption of critical infrastructures, particularly the electricity grid (Latorre & Decker, 2012).
2. Geo-political instability (Baev, 2016) which can lead to change in prices and
3. Environmental consequences which can lead to environmental degradation and increased global emissions, (IPCC, 2018).

The risk concept as Aven and Thedki (2021) further described can be illustrated (see figure 2) using (C, U) where C stands for consequences and U for uncertainties. This concept shows that the activity has potential to lead to undesirable consequences and the outcome of such is consequence is unknown.

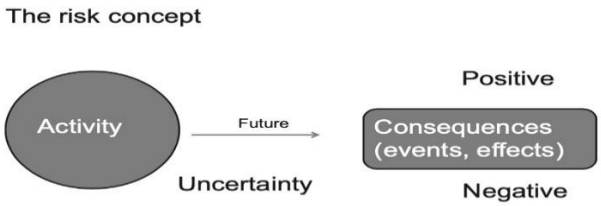
Risk concept as shown by Aven (2021) can be described as (C, U) or (A, C, U) where A denotes the activity. Aven (2021) went further to describe risk concept using: Risk description = (C’, Q, K) and (A’, C’, Q, K)

Where:

- A’ = is a set of specified undesirable events,
- C’ = some specified consequences,
- Q = a measurement or description of uncertainties
- K the knowledge that Q and (A,’ C’) are based on.

Figure 3

The basic features of the risk concept



Note: Source, Aven and Thekdi (2021)

Aven & Thekdi (2021) illustrated with a typical example where we think of a global risk problem like energy crisis and climate change. What effects will energy crisis, climate change etc. have on the environment and people? Will it have a significant impact on the global economy? When we look into the future, there are uncertainties.

3.2. Risk Management

Risk management as defined by (Aven & Thekdi 2021) covers all measures and activities conducted to manage risk, balancing developments and exploring opportunities on the one hand, and avoiding losses, accidents, and disasters on the other.

Risk management is a critical process that encompasses the identification, assessment, and prioritization of potential risks and the implementation of measures to reduce or eliminate their adverse effects on an organization or project (PMI, 2017; ISO, 2018).

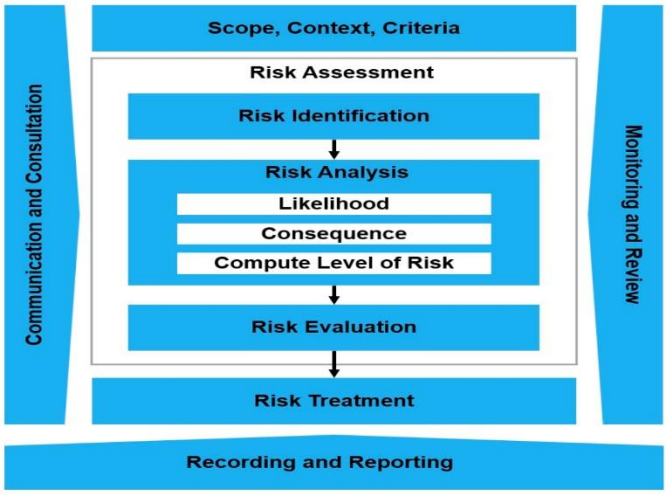
This process is divided into two main components: defining the framework and using it. Defining the risk management framework involves creating a plan that outlines the risk management process, including "what to do, when to do it, with which methods, and using which criteria" (PMI, 2017, p. 61).

Using the risk management framework on a regular basis is the other crucial part of risk management (Chapman, 2011). This involves implementing the plan created in the first part and monitoring for new risks that may arise over time. Regular reviews of the plan should be conducted to ensure that it remains relevant and effective in managing current risks (Hillson & Murray-Webster, 2017).

The ISO 31000 is a risk management standard that provides guidelines, principles, frameworks, and processes for implementing risk management in organizations. It involves the systematic application of policies, procedures, and practices to the activities of communicating and consulting, establishing the context and assessing, treating, monitoring, and reviewing, recording, and reporting risks. It comprises the activities described in the diagram below (see figure # 4):

Figure 4

ISO 31000:2018, Risk Management Process



Note: Source, ISO 31000 (2018)

- Establishing the context: this involves defining the scope of risk management, identifying stakeholders, and setting the risk management policy and objectives.
- Risk identification: this involves identifying potential risks that may affect the organization's ability to achieve its objectives. Risks can be internal or external, and can arise from various sources such as technology, finance, human resources, or the environment.
- Risk analysis: This involves assessing the likelihood and impact of identified risks and prioritizing them based on their potential consequences.
- Risk evaluation: this involves comparing the level of risk against the organization's risk criteria to determine whether the risk is acceptable or whether further action is needed to mitigate it.

- Risk treatment: this involves selecting and implementing appropriate risk management measures to reduce, transfer, avoid, or accept the risks. Risk treatment options can include implementing controls, transferring risk to another party through insurance or contracts, avoiding the risk altogether, or accepting the risk and monitoring it over time.
- Monitoring and review: this involve continuously monitoring the effectiveness of the risk management measures and reviewing the risk management process to ensure that it remains relevant and effective over time (ISO 2018).

Furthermore, risk management can be in set in three main categories as explained by Aven (2010):

- Strategic risk – the consequences in this case are related to acquisitions, mergers, laws, regulations, labour market and similar.
- Financial risk – the consequences in this case are related to the influence of stock prices, foreign exchange rates, interest rates and similar.
- Operational risk – the consequences are related to safety or security related events such as accidental events or intentional acts.

3.3. Risk Management Strategies

The basic risk management strategies as described by Aven (2010) are:

- Use of Risk assessment (Risk Informed)
- Cautionary/ Precautionary principles.
- Discursive

In addition to the above-mentioned strategies, Aven & Thekdi (2021) also described the risk-based which is the use of defined codes and standardization.

3.3.1. Risk Assessment Strategy (Risk informed)

This strategy is applied when there are moderate levels of uncertainties which have potential for severe consequences like in the nuclear industry. This is usually conducted using the risk assessment strategy.

This strategy is informed by risk assessment which provides a broad risk characterization, highlighting knowledge and uncertainties. The strategy is applied to reduce risk related to risk sources and events using avoidance and substitution and weight on reducing vulnerabilities and strengthening resilience for example containment, redundancy, and diversification etc. The major influencing factor is relevant amount of data and available models.

3.3.2. Cautionary/Precautionary and Resilience strategy

This strategy applies similar to the risk assessment strategy related to reducing risk related to risk sources and events using avoidance and substitution and weight on reducing vulnerabilities and strengthening resilience for example containment, redundancy, and diversification etc.

Containments such as avoiding spreading of a virus. Redundancy such as having a back-up in case of component failure and diversification in mixing completely distinct types of strategies such as in investments. It is usually applied when there is lack of understanding of underlying phenomena and complexities.

Precautionary Principle: defined by the Society for Risk Analysis (SRA) as an ethical principle expressing that if the consequences of an activity could be serious and subject to scientific uncertainties, then precautionary measures should be taken, or the activity should not be conducted.

The principle, which states that regularity actions may be taken in situations where potentially hazardous agents might cause harm to humans or the environment, even if conclusive

evidence about the potential harmful effects is not (yet) available, has since permeated most international environmental conventions and is also a cornerstone of European Union (EU) regulations and law (EU 2002, 2017).

Cautionary Principles: according to Aven (2010), this principle expresses that if the consequences of an activity could be serious and subject to uncertainties, then cautionary measures should be taken, or the activity should not be carried out. Thus, the key difference between the cautionary and the precautionary principle is that the latter refers to 'scientific uncertainties,' whereas the former just refers to uncertainties.

3.3.3. Discursive Strategy

This Applies when there are value differences and a potential for severe consequences example climate change risks, terrorism. It utilizes measures to build confidence and trustworthiness through the reduction of uncertainties and ambiguities, clarifications of facts and involvement of affected stakeholders in deliberation and accountability. It is used in political processes, participatory discourse, competing arguments and when beliefs and values are openly discussed.

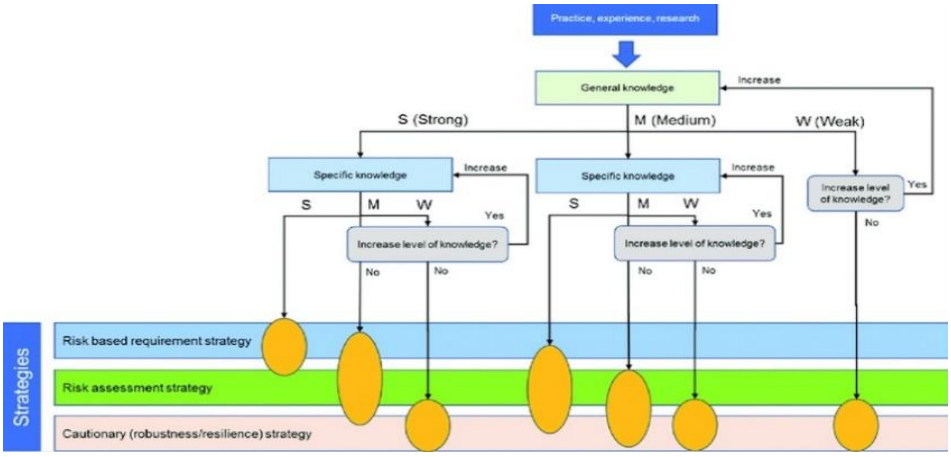
3.3.4. Risk-based requirement strategy

Risk-based requirement strategy is applied when there are simple risk problems, the phenomena is well understood, and the process considered are well understood and accurate predictions can be made with minor uncertainties. Examples are in many health and Transportation risks and system with a generic knowledge of its operations. The basic risk strategy here employs the use of codes and standards based on considerable experience and many risk assessments of similar activities. Also, statistical analysis and traditional risk assessments.

Aven & Thedki (2021), further explain that this standard, the "risk-based requirement strategy" is labelled "good practice" and is added to the other two basic risk management strategies (risk assessment informed and cautionary approaches) and that the idea is reflected in standards, for example the risk-related decision-making framework by ISO 17776 (ISO 2016). Aven & Thedki (2021) further explains that with strong knowledge and minimal uncertainties, the "good practice" approach is justified, whereas if the values at stake are high and the uncertainties are large, all strategies are required. (See figure 5)

Figure 5

A model for defining main risk management strategy, based on characterization of Gk and SK



Note: Source, Aven and Kristensen (2019).

3.4. Risk treatment Strategies

Aven & Thekdi (2021) explains that for all the Risk treatment strategies, the following components relates to how appropriate responses should be carried out:

Risk Avoidance

Risk avoidance in the energy sector refers to the strategic decision to completely refrain from engaging in activities or investments that are associated with significant risks, (Keppler

2017). It involves avoiding exposure to potential risks by not pursuing certain projects, technologies, or markets that are deemed too risky or uncertain (IEA 2018).

This could involve, Diversification of energy sources, implementing energy efficient measures, investing in energy backup systems, Employing Risk Hedging, and contracts to avoid risks of price fluctuations, Regulatory compliance and Risk assessment and Geographical and Political diversifications to reduce vulnerability to localized risks. (International Energy Agency, 2020).

Risk Reduction

Risk reduction in the energy sector refers to the implementation of measures and strategies to minimize or mitigate the potential risks and uncertainties associated with energy projects, operations, and investments. It involves identifying and assessing risks, developing risk management plans, and implementing actions to reduce the likelihood or impact of adverse events (IEA 2020).

Examples could include, implementing enhanced safety measures of stringent safety protocols and practices, investing in advanced technologies, and upgrading infrastructure, such as adopting digital monitoring systems and automation to enhance the efficiency, reliability, and safety of energy operations, reducing the potential for human errors and equipment malfunctions. (International Energy Agency, 2017).

Also developing comprehensive emergency response plans is essential for risk reduction in the energy sector. These plans outline protocols for handling emergencies, such as natural disasters, equipment failures, or fuel supply disruptions. By having well-defined procedures and coordinated responses, the sector can minimize the impact of unforeseen events and ensure swift recovery (International Atomic Energy Agency, 2018).

Also includes, effective communication and engagement with stakeholders, including local communities, regulatory bodies, and industry associations, which can contribute to risk reduction. By fostering transparent and collaborative relationships, the energy sector can address concerns, obtain valuable insights, and ensure compliance with regulations and industry best practices (International Association of Oil & Gas Producers, 2021).

Risk sharing

This refers to the allocation and distribution of risks among different stakeholders involved in energy projects or operations. It involves mechanisms and strategies to divide the potential risks and uncertainties associated with energy investments, technologies, market conditions, and regulatory environments. (IEA, 2020). By sharing risks, the burden is distributed among multiple parties, reducing the exposure and potential negative impacts on any single entity.

Examples of this could involve Power Purchase Agreements (PPAs) which are long-term contracts between electricity generators and buyers. They provide a mechanism for risk sharing in renewable energy projects (IRENA, 2020). By guaranteeing a fixed price for the electricity generated over the contract period, both parties share the risks associated with fluctuating energy prices and market uncertainties.

Also includes Joint Ventures and Partnerships where Energy companies often form joint ventures or partnerships to share risks in energy projects. These collaborations involve pooling resources, expertise, and financial responsibilities, distributing risks among the participating entities (IEA, 2020). Others are Insurance and Risk Hedging, Government support and guarantees. (IRENA, 2020).

Risk acceptance

According to ISO 301000:2018, Risk acceptance in the energy sector refers to a deliberate decision made by organizations or stakeholders to acknowledge and tolerate certain risks associated with their operations or projects. It involves a comprehensive evaluation of potential hazards, uncertainties, and their potential consequences, followed by a conscious decision to accept and manage those risks within defined parameters.

Risk acceptance is typically based on a thorough analysis of the risks, weighing the potential benefits against the potential negative outcomes. This could involve volatility in Energy Prices where Energy companies often accept the inherent risk of price volatility in energy markets, Fluctuations in oil, natural gas, and electricity prices can impact profitability. Companies may accept these risks as part of their business model and adjust strategies accordingly (IRENA, 2020). Others include Technological risks, Regulatory and Policy Risks (IEA, 2020).

3.5. Risk Perception

Aven & Thekdi (2021) defines Risk Perception as referring to a person's subjective judgment or appraisal of risk, which can involve social, cultural, and psychological factors. They argued that risk perceptions need to be carefully considered and incorporated into risk management, as they will influence how people respond to the risks and subsequent management efforts.

They further argued that the proper risk level is a result of a value and evidence/knowledge-informed process and balancing different concerns. The further explained that this process of balancing different concerns can be supported by cost -benefit methods but that this formal analysis needs to be supported by broader judgements of risks and uncertainties as well as

stakeholder involvement processes. Also, to protect values such as human lives and health, and the environment, the associated risks must be judged to be sufficiently low.

They further explain that risk perceptions are important for:

i) Identifying concerns but not necessarily for measuring their potential impacts and

ii) For providing value judgments with respect to unavoidable trade-offs in case of conflicting values and objectives.

Aven and Thekdi (2021) discussed risk perception in their book titled "Risk and Uncertainty Assessment for Natural Hazards". They outlined three main aspects of risk perception that are important to understand when assessing risk in various contexts.

The first aspect of risk perception is that it is subjective. People's perceptions of risk are influenced by their personal beliefs, experiences, and emotions. This means that different people can perceive the same risk differently. For example, some people may view skydiving as an extreme risk, while others may view it as a thrilling and safe activity.

The second aspect of risk perception is that it is context dependent. The same risk can be perceived differently depending on the context in which it occurs. For example, people may perceive the risk of a natural disaster differently depending on where they live and the frequency and severity of past disasters in that area.

The third aspect of risk perception is that it is dynamic. People's perceptions of risk can change over time as they gain added information or have new experiences. For example, people may become more or less concerned about the risk of a disease outbreak as they learn more about its spread and impact.

Overall, Aven and Thekdi (2021) emphasized the importance of understanding risk perception in order to effectively communicate and manage risks in different contexts. By

acknowledging the subjective, context-dependent, and dynamic nature of risk perception, risk assessors can better engage with stakeholders and develop strategies that are tailored to their needs and concerns.

3.5.1 Factors affecting Risk Perception

Control and social factors are two key factors that can impact risk perception. Individuals who feel they have control over a risk may perceive it as less risky, while social factors such as cultural norms, social influence, and trust can also impact how people perceive and respond to risks.

According to Aven (2010), control factors can significantly affect risk perception. People who believe they have control over a particular risk may perceive it as less risky than those who feel they have no control. For example, research has shown that individuals who feel they have control over a hazardous situation, such as a chemical spill or a natural disaster, are more likely to perceive it as less risky (Slovic, 1987). Conversely, people who feel they have no control over a risk are more likely to perceive it as more dangerous (Lerner & Keltner, 2001).

Social factors also play a role in risk perception. According to Aven (2020), social factors such as cultural norms, social influence, and trust can impact how individuals perceive and respond to risks. For example, cultural norms can influence risk perception by shaping people's beliefs about what is considered a "normal" level of risk (Slovic et al., 2000). Similarly, social influence can affect risk perception by encouraging individuals to conform to the beliefs and attitudes of their peers (Deutsch & Gerard, 1955). Trust in authorities and experts can also impact risk perception, as individuals may be more likely to trust and follow the recommendations of trusted sources (Slovic et al., 2000).

3.6. Black swans

The term was first introduced by Nassim Nicholas Taleb in his book "The Black Swan: The Impact of the Highly Improbable" (Taleb, 2007). The concept of black swans challenges the traditional way of thinking that events can be predicted based on past data and experiences.

Taleb (2007) refers to a black swan as an event with the following three attributes:

- First, it is an outlier, as it lies outside the realm of regular expectations, because nothing in the past could convincingly point to its possibility.
- Second, it carries an extreme impact.
- Thirdly, despite its outlier status, human nature makes us concoct explanations for its occurrence after the fact, making it explainable and predictable.

The black swan metaphor is commonly used for surprising events. It is defined as a surprising extreme event relative to one's knowledge (Aven 2014, 2015c). Furthermore, black swans are rare and unexpected events that have a significant impact on society and the economy. They occur more frequently than one might expect, and they can have far-reaching consequences.

There are several types of black swans (Aven and Krohn 2014), each with its own characteristics and impact on society.

According to Aven and Thekdi (2020) Black swan types include,

- Unknown Unknown
- Unknown Knowns
- Events Judged to have negligible probability of occurrence.

Taleb (2007) included Known Knowns as a type of Black Swan in his book titled The Black swan (Impact of the highly probable).

3.6.1. Unknown Unknown

These are events that no one is aware of and nothing in the past points to its possibility of occurring. These types of black swans can be confronted by:

1. Increasing scientific testing and research to reduce probability of occurrence.
2. Shifting focus from predicting events to reducing vulnerabilities and increasing resilience.

3.6.2. Unknown Knowns

This is simply regarded as intelligence failure. Unknown knowns are events or information that we may be aware of on some level, but we do not actively consider or acknowledge. These can include underlying assumptions, biases, and cultural norms that influence our thinking and decision-making without us being consciously aware of them (Taleb, 2007). In other words, unknown knowns are knowledge that exists, while others have it, others do not have it.

They can be confronted by

1. Improving the ability to share and receive knowledge across and between organizations (Using the High reliability Organization theory).
2. Improving risk assessments regarding assessing strength of background knowledge.

3.6.3. Known Knowns

Known knowns, on the other hand, are events or information that we are aware of and actively consider in our decision-making. These can include historical data, scientific research, and other forms of evidence that we use to inform our choices (Taleb, 2007). Known knowns are things we know and are aware that we know.

3.6.4. Events judged to have negligible probability of occurrence.

While events judged to have negligible probability of occurrence are events that are highly unlikely or impossible based on past data and experiences. These events are often dismissed as outliers or anomalies and may not be considered in risk management or contingency planning (Taleb, 2007).

However, as we have seen with black swans, events that are considered highly improbable can still occur and have significant consequences. One major challenge with this type of event is that the Risk assessment and the experience is based upon a set of physical, operational, legal, or other assumptions.

In his book "The Black Swan, (2007): The Impact of the Highly Improbable," Nassim Nicholas Taleb discusses the concept of black swan events and their implications. He emphasizes that traditional risk assessment methods often underestimate the likelihood and impact of rare events. Such events can invalidate the assumptions made in risk assessments and disrupt the stability of systems. These types of black swans can be confronted by

- Scrutinizing judgements about acceptable risks
- Scrutinize judgements about negligible probabilities.

To prepare for unknown unknowns, unknown knowns, known knowns, and events judged to have negligible probability of occurrence, it is important to adopt a mindset of "anti-fragility" (Taleb, 2012). This means designing systems and processes that can withstand and even benefit from unexpected events rather than simply trying to predict and prevent them. In order words, Resilient Systems.

Overall, the concepts of unknown knowns, known knowns, and events judged to have negligible probability of occurrence are important to consider in risk management and contingency

planning. By acknowledging the limitations of our knowledge and preparing for unexpected events, we can better protect ourselves and our society from the impacts of black swans.

3.7. Risk governance

In the last decade, the term "governance" has experienced tremendous popularity in a variety of fields, including literature, international relations, comparative political science, policy studies, sociology, environment, and technology, as well as risk research (Aven and Renn, 2010).

The International Risk Governance Council (IRGC, 2017) defines governance as "the actions, processes, traditions, and institutions by which authority is exercised and collective decisions are taken and implemented". On a national scale, governance describes structures and processes for collective decision making involving governmental and non-governmental actors (Neye and Donahue 2000). At the global level, governance embodies a horizontally organized structure of functional self-regulation encompassing state and non-state actors bringing about collectively binding decisions without superior authority (cf. Rosenau 1992; Wolf 2002).

The IRGC (2017) also defines risk governance as "the application of the principles of governance to the identification, assessment, management, evaluation, and communication of risks in the context of plural values and distributed authority". In IRGC’s understanding, risk governance includes the totality of actors, rules, conventions, processes, and mechanisms concerned with how relevant risk information is collected, analysed, and communicated and management decisions are taken.

Risk governance implies enabling societies to benefit from change while minimising the negative consequences of the associated risks. The governance of global, systemic risks requires cohesion between countries and the inclusion within the process of government, industry, academia, and civil society.

3.7.1. Risk Governance frameworks

Traditional understanding of risk governance

Traditionally, risk governance has been divided into three components: Risk assessment, risk management, and risk communication (Lyall & Tait, 2004; Aven & Renn, 2010).

Risk Assessment: describes the task of identifying and exploring the types, intensities and likelihood of the consequences related to a hazard or threat. In addition, it is also considered to be a tool of gaining knowledge about possible events and their consequences and is mainly located in the scientific area (Aven and Renn, 2010).

Risk Management: describes the task to prevent, reduce or alter the consequences identified by the risk assessment through choosing appropriate actions. Accordingly, it can be defined as a tool for handling risk by making use of the outcome of the risk assessment process (Aven and Renn, 2010).

Risk communication: a key element in the traditional understanding of risk governance. Its main function was initially defined as bridging the tension between expert judgment and the public perception of risk, which often varies to a considerable extent (Aven and Renn, 2010). The four main functions can be identified as part of risk communication:

- Education and enlightenment
- Risk training and inducement of behavioural changes
- Promotion of confidence in institutions responsible for the assessment and management of risk
- Involvement on risk -related decisions and conflict resolution

In the theory part risk management was introduce as an entire process where risk communication and assessment are part of. In this section it is important to clarify that when related

to risk governance, Aven and Renn (2010) present risk assessment, management, and communication as three different steps to illustrate how risk governance was executed traditionally prior to the introduction of integrated frameworks.

IRGC framework

The generic risk categories of assessment, management and communication are not always considered as sufficient to analyse and improve risk governance processes. The characteristics of modern systemic risks require new concepts, which can deal with emerging risks. This means, that besides the traditional dimension of risk the socio-cultural context must be included as systemic risks are characterized by affecting the whole "system" that humans live in. (Aven and Renn, 2010)

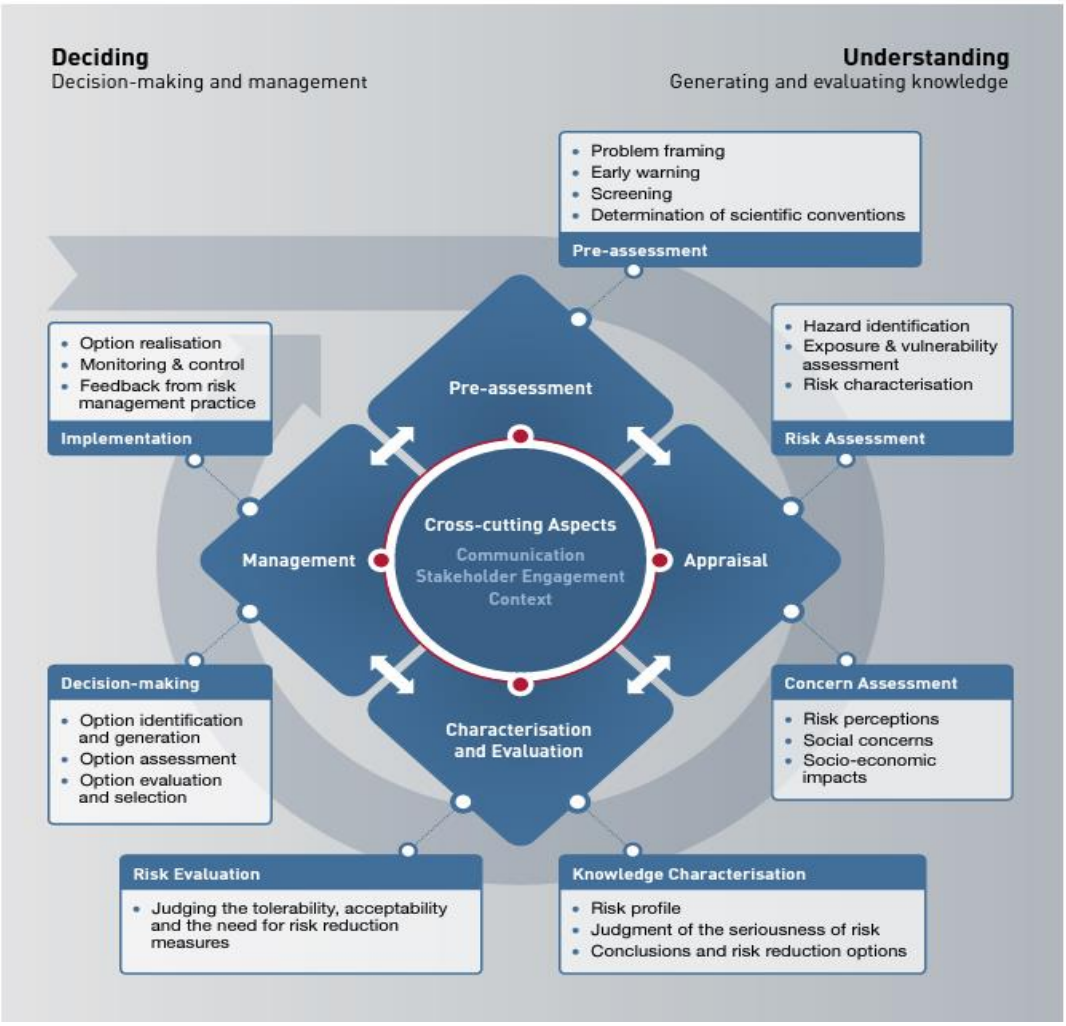
The IRGC framework that has been developed maps out a standard approach for the process of investigating global risk issues and designing appropriate governance strategies across industries (Aven & Renn, 2010). With the IRGC framework having received approval from both scholars and policymakers in many fields for conceptualizing and conducting risk governance processes (Preben H. Lindøe and Jacob Kringen, 2015).

In relation to this thesis, the authors have chosen these two approaches as primary theoretical basis to evaluate how the UK and Germany apply their risk governance.

The IRGC framework is described in more detail in figure # 6.

Figure 6

Detailed visual representation of the IRCG Risk Governance Framework



Note: Source, IRGC. (2017). Introduction to the IRGC Risk Governance Framework, revised version.

3.8. Energy Sector/Industry

The energy sector is a large and all-encompassing term that describes a complex and interrelated network of companies, corporations, countries directly and indirectly involved in the production and distribution of energy needed to power the economy and facilitate the means of production and transportation (Global industry classification standard, 2020).

The companies within the energy sector are involved in distinct types of energy. For the most part, energy companies/organizations are categorized based on how the energy that they produce is sourced and will typically fall into one of two categories:

- Non-renewable: petroleum products and oil, natural gas, gasoline, diesel fuel, heating oil, nuclear and coal.
- Renewable: hydropower, biofuels such as ethanol, wind power and solar power.

For the purpose of this thesis and the energy crisis evaluation, only the distinct types of energies considered in the energy sources mix of each country will be considered. The UK and Germany have similar energy sources mixes, which include fuel (oil, natural gas, coal), nuclear, and renewables (solar, wind, biomass, hydro).

4. Theoretical Findings

The following section provide insights into the theoretical findings related to the research questions. Moreover, this chapter presents the risk and crisis management practices implemented in the EU and the influence over the UK, Germany, and the region. Finally, this chapter serves as an introduction to the next one where the discussion merges the theoretical basis and findings.

4.1. Understanding risk and crisis management in the EU, the UK and Germany.

To completely understand how any country in Europe handle risk and crisis, it is important to study them as a whole and not individually due the immense number of agreements and treaties that have been signed since 1992 with the Maastricht Treaty, following the adoption of the EU Security Strategy in 2003.

Additional actions in this topic were taken with the adoption of the Lisbon Treaty in 2009, the establishment of the External Action Service in 2011 and the adoption of a comprehensive approach to crisis management in 2013. All these policies were finally implemented in 2016 with the signature and establishment of 35 Common Security and Defence Policy (CSDP) operations of various kinds in different regional settings (NUPI, 2016).

4.2. Risk Management

European countries risk governance has a long tradition of risk assessment, reduction, and management. Standard risk assessment and management procedures such as the ones described in section 3 have resulted in major risk reductions with respect to conventional and sectoral risks such as occupational, health, products, transportation, and mobility (SAPEA, 2022).

As part of the standard risk assessment, the EU (the same methodologies applies in the UK and Germany) implemented since 2008 a risk assessment methodology guideline to ensure that

the broader categories of public risk were protected under an EU harmonization legislation (European Commission, 2015).

The EU legislation in terms of risk assessment stablishes ‘risk assessment’ as the overall process of risk identification, analysis, and evaluation (European Commission, 2015):

- Risk identification is the process of finding, recognising, and describing risks.
- Risk analysis is the process to understand the nature of the risk and to determine its magnitude, which results from the combination of consequences and their likelihood.
- Risk evaluation is the process of comparing the results of risk analysis with risk criteria to determine whether the risk and/or its magnitude is acceptable or not.

This type of risk assessment approach is carried out in numerous domains, across the Commission and EU agencies like the European Food Safety Authority, the European Medicines Agency, the European Union Aviation Safety Agency, and the European Union Agency for Cybersecurity among others (SAPEA, 2022).

In table #2, it can be seen an example of the above-mentioned methodology. The description of the phases and corresponding steps used in the risk assessment of new health products as described in the Product Safety — EU Rapid Information System (RAPEX) Guidelines implemented for the purpose of market surveillance activities.

Table 2

EU Risk Assessment phases and corresponding step.

RISK ASSESSMENT PHASES	RISK ASSESSMENT STEPS
a) Risk identification	1. Defining the product; 2. Identifying the hazard(s) 3. Identifying the subject(s) at risk
b) Risk analysis	4. Describing how the hazard may harm the subject; 5. Describing the potential harm
c) Risk evaluation	6. Determining the severity of harm; 7. Determining the probability of harm; 8. Determining the risk level by combining the severity of harm and the probability of that harm occurring in the scenario described.

Note: Source, European Commission (2015)

In relation to risk assessment and management, broad descriptions of the methodologies employed in Germany and the UK rely on the standard ISO 31030. In the UK specifically, after Brexit most regulations kept the EU basis nevertheless several areas were reviewed to deliver an improved approach of risk assessment within the Great Britain (GB) context (SAPEA, 2022).

4.3. Crisis management

A crisis can be defined as a perceived severe threat to the fundamental values or functioning of a society or system, requiring an immediate response that must be delivered under conditions of (deep) uncertainty (Boin, Ekengren, & Rhinard, 2013; Rosenthal, Charles, & Hart, 1989). This means that crises essentially bring together a fundamental threat to our societies with time pressure and tremendous (deep) uncertainty, which hampers our possibilities to predict (French & Niculae, 2005). Furthermore, crisis management aims to prevent a dangerous situation from turning into a disaster.

In the EU the crisis definition is not well stablish, its understanding varies from internal crises (e.g., a transport crisis), perceived threats to justice and home affairs (e.g., uncontrolled migration influxes), or external crises (e.g., international conflict such as the current war in Ukraine) (Boin, Ekengren and Rhinard, 2013). In this sense, three types of crises can be defined at a governance and geographical scale (Boin, Ekengren and Rhinard, 2013):

- Type I, Local Crisis: play out within the boundaries at a low administrative level, such as a village, city, or region. A local crisis can be geographically located and does not 'move' beyond the administrative boundaries.
- Type II, Crises within the state: unfold within the borders of the nation state. They conventionally prompt a response from local or national emergency services or civil protection units.
- Type III, Transboundary crises: affect multiple sectors in multiple states. These crises are not static and go across geographical and sectoral boundaries. Within this type of crises, it is possible to distinguish:
    - EU-wide or global large-scale events such as epidemics and pandemics, financial crises, migration crises or large-scale extreme weather events (heatwaves).
    - Transboundary events that occur in border regions, such as radioactive clouds, riverine pollution, or flooding.

The current Energy crisis as per documentation reviewed falls into: Type II crises at a country level and Type III as EU level. This is due to the different risk mitigation actions in place that involved different members and associations.

As of 2016, The EU (at that point in time, the UK was also a member) followed a methodological cycle that was follow as part of the strategy to take actions in crises that erupt in an unpredictable manner (see figure 7).

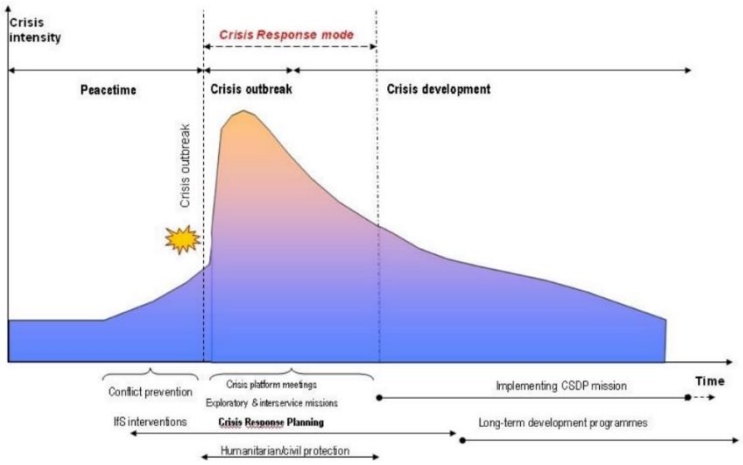
1. Pre-crisis phase: when the EU can exert influence on conflict dynamics and preparedness and responses through early warning and conflict-prevention efforts. Although crises do not always 'begin' at a defined moment, the origins and motivating factors can often be traced back, and unresolved issues from previous crises or other crises in the region can impact on their escalation.

2. Crisis phase: when response and management, rapid-reaction mechanisms, possible deployment of a mission, aid packages, links to other pre-existing policies and how these impact on conflict dynamics are applied.

3. Post-crisis phase: when stabilization and state-building efforts for peace, stability and human security are implemented. The aim is no longer crisis response, but crisis management and prevention. Here attention must be paid to the inter-organizational competition and cooperation in crisis management.

Figure 7

EU, Crisis phases and actions



Note: Source, NUPI (2016)

Indications in recent publications showed a different approach from the EU and the UK with respect to handling more complex risk scenarios that can escalate to crisis or disaster scales. The new framework for strategic crisis management highlights the interplay of risk and crisis management (see figure 8).

In this framework, risk management aims are to identify, assess, evaluate, and then monitor, control, or ideally prevent a risk from occurring. The control and monitoring steps should match the preparedness in the crisis management cycle. This approach is designed to ensure a faster and more efficient response.

Figure 8

Integrated risk and crisis management cycles

Note: Source, SAPEA (2022)

4.4. Macro concept of energy security

From the documentation, it was possible to determine that those European countries decoupled the Energy crisis from the crisis management frameworks the used for natural disaster or man-made accidents. The reasoning behind this is the political aspect attached to the energy supply and governments responsibilities on securing continuous energy supply to all the

individuals. This obligation is the same in the UK and Germany. In Germany's case, is it a shared responsibility with the EU energy commission.

Sovacool (2011) in his book introduces the concept of Energy security and presents forty-five definitions from diverse sources. For this thesis scope, six concepts were chosen among all definitions as they described the term Energy Security from the EU, the UK and Germany perspective. The remaining three concepts focus on a risk perspective rather than a governance point of view. These last three concepts tackle different point of views more aligned with the strategies, framework and metrics used to quantify the energy security at a standardise level.

See tables 3 and 4 respectively with the definitions explained above.

Table 3

Energy Security definitions by the EU, the UK and Germany

Source	Definition
United Kingdom Department of Trade and Industry	Environmental sustainability, or carbon dioxide emissions; reliability, or having the "right" infrastructure, regulatory system, and liberalized market; competitiveness and productivity, or energy costs that do not discourage investment and growth; social equity, or minimal fuel poverty.
Deutsch	Connection between the economic activity that occurs in both domestic and international energy markets and the foreign policy response of nations
European Commission	Uninterrupted physical availability of energy products on the market at an affordable price for all consumers

Note: Source: Sovacool (2011)

Table 4

Additional Energy security definitions.

Source	Definition
Asia Pacific Energy Research Centre	Ability of an economy to guarantee the ability of energy resource supply in a sustainable and timely manner with the energy price being at a level that will not adversely affect the economic performance of the economy, spread across the four A's of availability, accessibility, acceptability, and affordability
Kessels et al	Diversification of supply sources, robust security margins (including spare capacity, emergency stocks, redundancy of infrastructure), flexible and competitive energy markets, mutual interdependence among companies and governments, mutual interdependence between suppliers and consumers, physical security for consumers and producers, quality of information to the public, investments in innovative technologies, lowered energy imports
Nuclear Energy Agency	Minimizing vulnerability to unique and unforeseeable events threatening the physical integrity of energy flows or leading to discontinuous energy price rises, independent of economic fundamental.

Note: Source, Sovacool (2011)

Sovacool (2011) proposed a framework for the analysis of energy security at a country level. The theoretical framework includes the following steps:

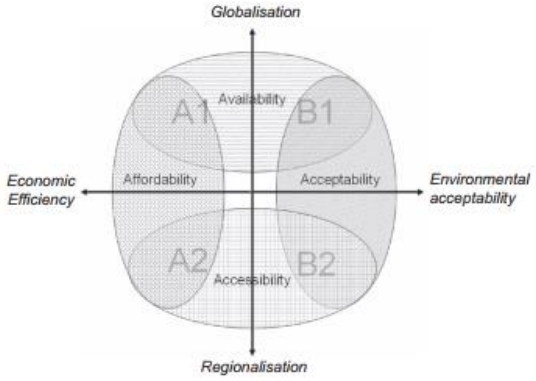
1. Define objective and subjective measures of energy (and environmental) security to be evaluated.
2. Collect data and develop candidate energy paths/scenarios that yield roughly consistent energy services but use assumptions different enough to illuminate the policy approaches being explored.
3. Assess the relative performance of paths/scenarios for each energy security measure included in the analysis.
4. Incorporate elements of risk.
5. Compare path and scenario results.
6. Eliminate paths that lead to clearly suboptimal or unacceptable results and iterate the analysis as necessary to reach clear conclusions.

Furthermore, the Asia Pacific Energy Research Centre (APERC,2007) proposed a classification scheme of four elements related to security of supply (SOS). The four elements are (see figure #9 for reference):

- Availability – or elements relating to geological existence, potential reserves.
- Accessibility – or geopolitical elements, specifically related to infrastructure to receive the supplies.
- Affordability – or economical elements.
- Acceptability – or environmental and societal elements.

Figure 9

The energy spectrum, the four dimensions of energy security and their relation to global orientations



Note: Source, Sovacool (2011)

These two approaches have been adopted by many countries at a global scale since its first introduction in Asia. Among the countries using this approach are the US, UK, and Middle east region. In the case of the UK and Germany, although there are not mentioned in their energy security risk assessments and crisis management plans to reduce the impact of the current energy crisis, the overall results follow the above-mentioned framework and aims to fulfil the four dimensions of energy security.

5. Discussion

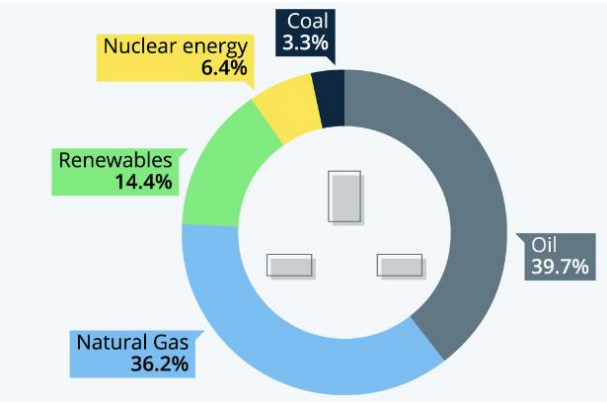
This chapter analyses the theoretical basis and findings in order to answer the research questions which look at the energy crisis in the UK and Germany from a risk perspective. Furthermore, it leads the discussion towards the main points being presented as part of the conclusion in the next chapter.

5.1. Energy Crisis in the UK

To Understand the energy crisis in the UK it is necessary to first review the energy mix consumption and the energy to produce electricity. In 2019, the energy consumption by fuel type was primarily dominated by fossil fuels adding to 76%. Effort in the country for increasing the renewable energy have shifted this percentages but the overall figures remain similar. (Refer to figure # 10)

Figure 10

2019 UK's Energy mix. Primary consumption by fuel type



Note: Source, Department for business, energy, and industrial strategy (2022)

According to UK's National Grid Electricity System Operator (ESO) analysis from 2022, the energy mix for the UK have significantly changed is made up as follows:

- Gas - 38.5%
- Wind - 26.8%
- Nuclear - 15.5%
- Biomass - 5.2%
- Coal - 1.5%
- Solar - 4.4%
- Imports - 5.5%
- Hydro - 1.8%
- Energy storage - 0.9%

The share of the UK's electricity supplied by renewable energy (RE) sources has increased substantially to the point that RE is now the second largest source after gas: It now supplies 26% of the electrical needs. This is greater than the amount supplied by nuclear – about 15% to 18%. Coal, hydroelectric, and mainly gas (~40%) constitute the other sources.

Although there have been significant improvements to reduce dependency on fossil fuels and Russia as a key supplier, several factors had played a role in the origin and intensification of the current in the UK, below a list of some of them:

- As a result of the Brexit transition, the UK Emissions Trading Scheme (UK ETS) replaces the UK's participation in the EU ETS, resulting in price volatility and market uncertainty.
- The UK's overreliance on gas for heating and cooking, despite having some of the lowest amounts of gas storage capabilities in Europe, means the country its particularly

exposed during these challenging times. One of the UK's largest natural gas storage facilities Rough, was closed in 2017, with the government declining to subsidise the cost of ongoing repairs and maintenance. This explains why the UK has so little gas storage capacity compared to equivalent EU countries. Owing to the energy crisis, Rough has since been recommissioned and is expected to reopen in 2023.

- Over the past decade, five nuclear power stations have closed in the UK, including Wylfa, Dungeness B, Hunsterston B and Hinkley Point B. Though not directly related to the energy crisis, these closures may be of detriment to the diversity and resilience of the UK's energy supply.

In terms of risk assessments, the country tackles the problem from two different angles. Focusing on the net zero target and improving them RE strategy with a new plan being rolled out in 2023 and on the fossil fuels, they performed national risk assessments in 2017 with a further review in 2022. Furthermore, the country placed a 10-point plan to ensure energy security.

The current plan for the UK to overcome the energy crisis covers the for A's for energy security. It is not directly stated but the actions can be framed over the following categories:

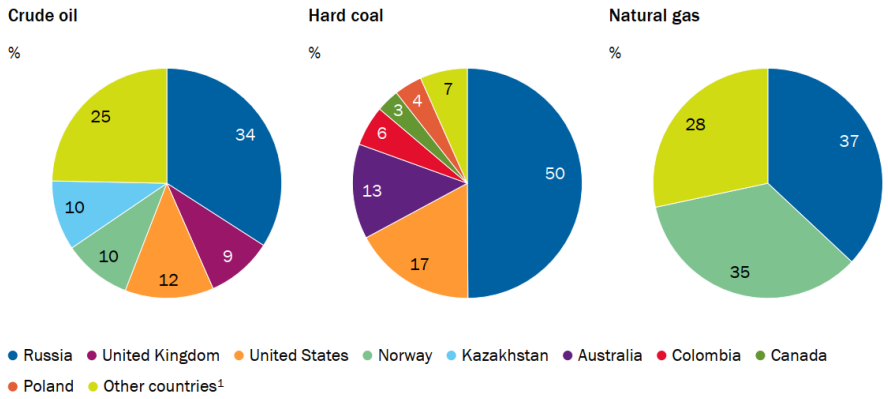
- Availability: increasing production and storage facilities.
- Accessibility: reactivating nuclear plants to ensure energy mix.
- Affordability: putting in place measures to warranty population can afford to pay the bills and helping business.
- Acceptability: continue to invest in green energies.

5.2. Energy crisis in Germany

The recent Russian invasion to Ukraine and as the sanctions placed over the nation it is one of the major contributors of the energy crisis intensification in Germany. However, the origins go beyond this, and it is attached to a several factor, and decisions previously taken in the energy sources, suppliers, infrastructures and policies. Figure # 11 is a representation of Germany's import dependence in 2021, prior to Russia's war aggression.

Figure 11

Germany's energy import dependence by supplier country in 2021

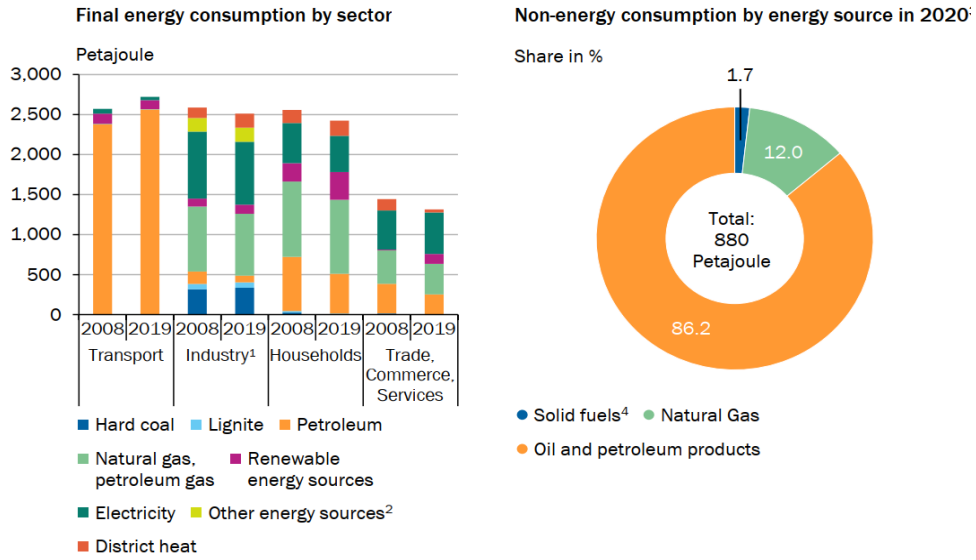


Note: Source, German Council of economic experts (2022)

Additionally in figure # 12, it can be highlighted the level of dependency on fossil fuels compared to RE in the different economic sectors.

Figure 12

Germany energy consumption 2020



Note: Source, German Council of economic experts (2022)

In terms of risk assessments, Germany strategy consist of two fronts, the RE plan for Net Zero targets and a national plan with different actions being taken to reduce Russia's supply dependency and to align with the EU plan "REPowerEU."

The result from the most recent gas supply risk assessment done in September 2019 generated the following conclusions: "Germany's natural gas supply is very secure and reliable. This is especially true of the supply to "protected customers," e.g., private households, which are of particular significance in the SoS Regulation".

Additional conclusions evaluated the likelihood of a serious deterioration or severe crisis in supply as very small and as for preparation indicated that precautionary measures have to be taken for such an event so as to ensure not only the necessary cooperation between all involved parties but also the availability of the relevant measures. Even though the assessment covered the full issue of gas supply, it was more focus in the internal distribution channels and overlooked at supplier's diversification and distribution channels.

In Germany, the security of supply (SoS) Regulation distinguishes between three crisis levels: early warning level, alert level, and emergency level. Currently all the plans have been taken as for the emergency level type of crisis for gas supply.

The current plan for Germany to overcome the energy crisis covers the for A's for energy security. It is not directly stated but the actions can be framed over the following categories:

- Availability: ensuring business with different suppliers and making floating platforms available to store liquid gas.
- Accessibility: in terms of improving the port access via different areas and countries, making them less dependent to Russia imports.
- Affordability: putting in place measures to warranty population can afford to pay the bills and helping business.
- Acceptability: continue to invest in green energies.

A summary evaluation of distinct types of energy source is presented as follow:

LNG

- Germany has leased four floating storage and regasification units (FSRUs) to quickly start importing liquefied natural gas (LNG) directly and replace Russian volumes.
- Two of the FSRUs will be stationed in Wilhelmshaven and Brunsbuettel, able to jointly handle up to 12.5 billion cubic metres a year. Efforts to build fixed terminals at those two locations at a later stage are also underway.
- Germany is also in talks with Qatar and Canada, among others, to raise LNG imports in the medium term. German utilities have existing supply agreements with Qatar, Australia, and the United States.

COAL

- Germany has passed a law to bring back oil- and coal-fired power plants into the country's energy mix in case of a critical gas supply situation. This could add 10 gigawatts of reserve capacity on an interim basis in a deal that runs until March 31, 2024.

NUCLEAR

- In autumn 2010, the Federal Government adopted an Energy Concept that sets the course for Germany’s transition to the age of renewables. In this Energy Concept, nuclear energy was assigned the role of 'bridging technology' to be used up to the point where renewables have become reliable and economically viable enough to replace them, and the necessary infrastructure has been put in place.
- Following the disaster at the Japanese nuclear power plant of Fukushima in March 2011, the German government decided to accelerate the energy transition and to completely phase out power generation in German nuclear power plants by the end of 2022, now extended due to the energy crisis to end of 2023.
- Germany's nuclear power will continue as its minimum, the operation of three nuclear power plants was extended until 15 April 2023, further extensions will be evaluated accordingly but the plan is to phase-out all nuclear capacity by end of 2023.

5.3. Further analysis of the energy crisis from a risk perspective

A comparison among the different strategies applied in the UK and Germany are summarised in the table #5 below linking the actual results with the theories presented in chapter three.

Table 5

Differences and Similarities among the risk strategies.

	UK	Germany	EU
Risk Management strategies	A mixture of a cautionary and discursive principles	A mixture of a cautionary and discursive principles	A mixture of a cautionary principle and discursive
Risk treatment strategies	Risk reduction	Risk reduction	Risk sharing
Risk perception	High risk due to lack of transparency and control over the energy crisis	Medium risk due control over the energy crisis and important level of transparency	Risk perception across the region is high due to impact on society and the risk over the basic needs. There is transparency on the actions and the time it will take to go over the immediate effects of the war.
Risk governance	There are indications that a framework similar to the one presented by the IRGC was used as includes population consultation.	There are indications that a framework similar to the one presented by the IRGC was used as includes population, experts' consultations, and high degree of stakeholder's involvement.	There are indications that a framework similar to the one presented by the IRGC. Additionally, the EU had already adopted IRGC classifications of diverse types of risk.

Note: Source, Galue and Obinna (2023)

Even though the energy crises in the UK and Germany possesses similarities and differences with respect to the origins, energy sources mix, and actions plans. There is a common and relevant factor which is both countries dependency to natural gas. The UK ranks fourth on gas dependency across Europe while Germany is the country that consume most of the natural gas in the EU.

Although both countries had Russia as fossil energy supplier meaning gas, oil or coal, Germany had the highest dependency accounting for as of end-April 2022, about 35 percent of Germany's natural gas imports (33 billion cubic meters (bcm) a year), 12 percent of crude oil, and

8 percent of coal, according to Germany's economy ministry. In the UK, the dependency round less than 5 % in all categories.

The above points serve as introduction to define this crisis within a risk scenario. While some authors argue that this event was unprecedent other argue that there were significant sings that indicate that Russia would once again use the gas dependency in Europe as a weapon.

In this sense the current crisis can be define as black swans' type two and three, being the origin in one hand a mixture of risk scenarios classified as extremely low probability of occurrence such as the gas dependency, distribution channels, supplier diversification all happening at the same time creating a perfect storm.

In the other hand Russia invasion to Ukraine and use of the oil and gas dependency as a weapon is a Known-Unknown type of event. Sovacool (2011) presented a chronological order of events that could have serve as an indication that Russia's dependency had some uncertainties and could create a significant impact.

For example, Russia restricted natural gas transmission to Turkmenistan in 1997 to coerce higher prices after a dispute over contracts. Russia, again, used control of their natural gas pipelines in 2005 to manipulate the market to their advantage and gain concessions on gas prices from Ukraine, even at the risk of blackouts and international outrage. Russia has since used the same tactic at least five times in natural gas disputes with Belarus, Georgia, Moldova, and Ukraine in 2007 and in an oil pricing dispute with Germany in 2008 (Sovacool, 2011).

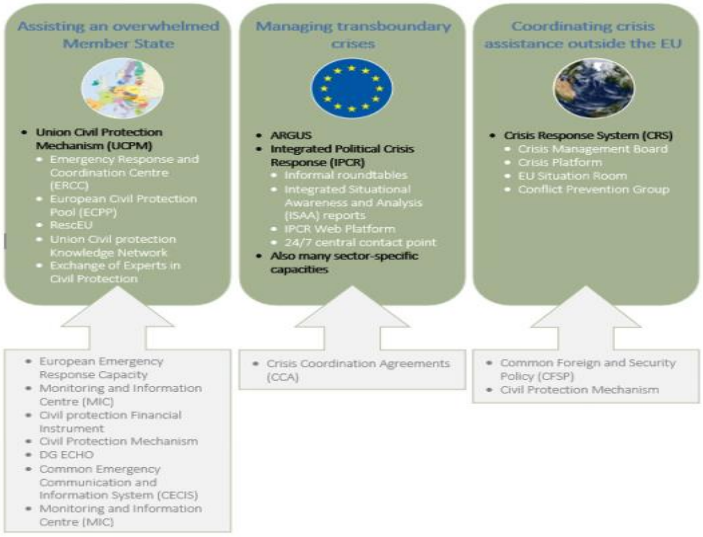
5.4. EU influence and collaboration in the region

Since the 1980s, the EU has gradually developed a suite of capacities and mechanisms that aims to support member states in managing crises (NUPI, 2016). Since the Lisbon treaty in 2019, the member states have granted an influential mechanism role to the EU to serve as a coordinator.

With regards to risk, all member states agreed that risk assessments are a valuable tool and could constitute a basis for further EU cooperation. The EU has been granted a role in reviewing national risk assessments and suggesting improvements. More recently, the EU has adopted resilience as a blanket strategy to enhance societal preparedness for crises and disasters. Figure #13 below summarizes the EU influential capabilities:

Figure 13

EU crisis management capacities. Source



Note: Source, SAPEA (2022)

The EU as a coordinator role, stablished a crisis management strategy for the member states to join forces and reduce the energy demand impacts. The plan objectives are to significantly

reduce dependency on Russian fossil fuels and accelerate the energy transition. The REPowerEU plan put forward a set of actions (See figure 14):

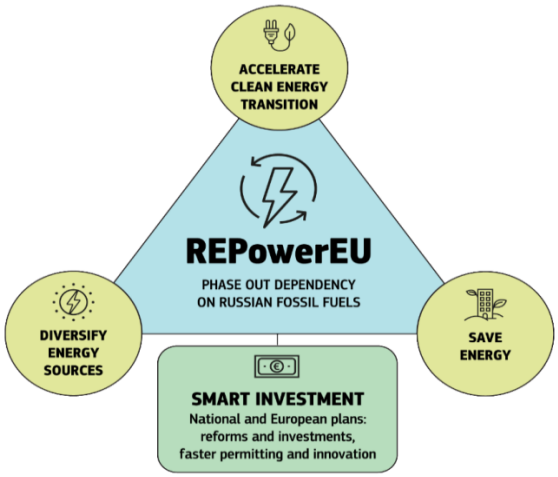
- Save energy.
- Diversify supplies.
- Quickly substitute fossil fuels by accelerating Europe's clean energy transition.
- Smartly combine investments and reforms.

It is considered by the EU that these actions will structurally transform the region energy system. The actions required effective coordination between European regulatory and infrastructure measures, as well as national investment and reforms and joined-up energy diplomacy.

They also require coordination between action on the demand side, to reduce energy consumption and transform industrial processes to replace gas, oil and coal with renewable electricity and fossil-free hydrogen, with action on the supply side to create the capacity and framework to roll out and produce renewable.

Figure 14

REPowerEU, Energy Crisis Management strategy.



Note: Source, European Commission (2023)

6. Conclusion

This thesis has attempted to analyse the current energy crises in the UK and Germany from a risk perspective. This task involved the review of different papers, books, report, NRA, government crisis management plans among other sources of information as explained in previous chapters.

As a summary of the work executed for this thesis, the authors present the following conclusions:

- Authors managed to answer all the research questions.
- The UK and Germany have developed toolboxes which provides key definitions, methodologies, suggestions, and examples on how to carry risk assessments. These documents are based on the EU regulations as part of treaties signed among all the countries participating in the commission.
- European countries in general seems to agree that all risk assessment and management methodologies as per EU commission recommendations should be based in ISO 31010. This is the case also for the UK where the BIS (British institute of Standardisation) agrees in the same.
- EU's own understanding of crisis response refer to crises that may be both internal and external caused by human-caused and/or natural disasters such as international conflict, large-scale disasters, or a failed state outside EU territory. The EU classified the crisis into three distinct types of crises: national crisis (Type I), external crisis (Type II), and transboundary crisis (Type III). The same classification is shared across the region.
- When related to Energy, a different concept in crisis management arises which is Energy Security. This is managed in a completely different framework compared to a

conventional risk due to the political aspect attached to it. In the UK case, part of the government duties is to warranty the continue energy supply. When looking at Germany, this responsibility is shared among the country specific government and the EU commission.

- A common factor that is missing in most strategies to safeguard any risk or crisis is the lessons learned tracking and how this are implemented in order to avoid reoccurrence or mitigate the impacts in case the likelihood of occurrence cannot be eliminated.
- Another common factor missing in most of the frameworks presented are the communication and monitoring stages of the risk management process. Even though all the national risk assessments must be reviewed every three years, there is not clear indication of how the process is to capture continuous improvements, lessons learns and new measure to reduce the likelihood of the incidents from happening.
- The current plan for Germany to overcome the energy crisis covers the for A's for energy security. It is not directly stated but the actions can be framed over the following categories:
    - Availability: ensuring business with different suppliers and making floating platforms available to store liquid gas.
    - Accessibility: in terms of improving the port access via different areas and countries, making them less dependent to Russia imports.
    - Affordability: putting in place measures to warranty population can afford to pay the bills and helping business.
    - Acceptability: continue to invest in green energies.

- The current plan for the UK to overcome the energy crisis covers the for A's for energy security. It is not directly stated but the actions can be framed over the following categories:
    - Availability: increasing production and storage facilities.
    - Accessibility: reactivating nuclear plants to ensure energy mix.
    - Affordability: putting in place measures to warranty population can afford to pay the bills and helping business.
    - Acceptability: continue to invest in green energies.

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Anexo # 1

Table 6

Description of all the final studies used during the scoping.

Title	Author / Year	Method and research design	Objective / Research questions	Territory of focus	Result / Findings
How Governing International Trade in Energy Can Enhance EU Energy Security	Rafael Leal-Arcas 2015	Qualitative	Suggests the importance of developing effective trade policy instruments to enhance EU energy security	Examining the law and governance of international trade in energy and its effects on EU energy security to identify the existing gaps in energy trade governance	1. EU energy security can be fostered if energy trading is subject to governance through greater legal cohesiveness and international political and economic co-operation. 2. Without a deep understanding of the current systemic aspects of energy trade governance and their implications for EU energy security, it is impossible to achieve effective change
EU Energy Policy: Sustained by Fragile Solidarity, Indispensable for Eurasian Security	Memduh Karakullukçu2016	Qualitative	Highlight the complexity of the European Union's (EU) energy security challenge, which is not only an external balancing act but also an internal market design and governance issue. The paper argues that mismanaging the process of managing energy security can be highly corrosive to the EU's internal cohesion. The paper also emphasizes the importance of the EU's broader geostrategic role in shaping global relations and alliances through ensuring the openness of global energy trade and preventing locked-in energy dependencies with geostrategic implications.	European Union	The findings of the paper suggest that the EU needs to adopt an initiative-taking policy trajectory to adequately prepare itself for energy-related contingencies and adversities and to fulfil its broader geostrategic role in shaping global energy dynamics. The paper highlights the potential risks associated with the EU's failure to effectively manage its energy security challenge and emphasizes the need for strategic planning and action with long-term effects
Energy Governance in the G7 and G20 after the Ukraine Crisis	Thijs Van de Graaf 2017	Qualitative	Examines the contribution of the G7 and G20 to energy governance following Russia's annexation of Crimea in March 2014 and its continued support for Russophile separatists in eastern Ukraine afterward	Focus of this contribution lies mostly on the G7 Energy Ministers Meeting in Rome in May 2014 and the G7 Brussels Summit of June 2014, where energy was high on the agenda because of the Ukraine situation	1. Misreading the Ukraine crisis as an energy crisis could lead the G7 leaders to propose the wrong policy solutions, such as shipping US LNG across the Atlantic to 'rescue' Europe, an idea that is practically infeasible. 2. The agenda of global energy governance is much broader than just energy security and the Ukraine crisis should not divert attention away from pressing issues such as the need to transition to zero-carbon energy systems and to provide sustainable energy services for all.

EU Energy Union	Øystein Noreng 2019	systematic approach	The paper aims to analyse the European Union's (EU) Energy Union initiative, which was launched in 2015. The author seeks to examine the potential impact of this initiative on the EU's energy security and climate change goals	The paper focuses on the European Union, its member states, and their energy policies. The author provides an overview of the EU's energy market, including its structure, governance, and key players	The paper provides a critical analysis of the Energy Union initiative and its potential impact on the EU's energy security and climate change goals. The author argues that the Energy Union initiative has the potential to increase the EU's energy security by reducing its dependence on foreign sources of energy. However, the author also notes that the initiative faces several challenges, including the need for significant investments in energy infrastructure and the lack of a common EU energy policy. The paper concludes that the success of the Energy Union initiative will depend on the EU's ability to address these challenges and develop a coherent and coordinated approach to energy policy.
Is UK energy policy drivingenergy innovation–or stifling it	Candida J Whitmill 2012	The paper is an analytical article that uses a case study approach to examine the impact of UK energy policy on energy innovation. The author uses a qualitative method to analyse the policy landscape and to assess the impact of policy on innovation in the energy sector.	The aim of the paper is to assess the impact of UK energy policy on energy innovation. The author examines the policy landscape and evaluates the extent to whichpolicy is driving or stifling innovation in the energy sector	The paper has a territorial focus on the UK. The author examines the UK energy policy landscape and the impact of this policy on energy innovation in the UK	The paper finds that UK energy policy has had a mixed impact on energy innovation. The author argues that while some policy initiativeshave driven innovation, others have had a stifling effect on innovation and concludes by emphasising the importance of a balanced and flexible approach to energy policy that is capable of driving innovation while also ensuring energy security and affordability.
Energy Crisis Conundrum	Yana Popkostova 2022	The paper is an opinion piece that draws on various news articles, reports, and data sources to discuss the current state of the global energycrisis	The aim of the paper is to provide an overview of the causes and consequences of the ongoing energy crisis, particularly in the context of the COVID-19 pandemic. The paper also highlights some of the key policy and investment decisions that are necessary to address the crisis and ensure a more sustainable energy future	The paper takes a global perspective and discusses the energy crisis in various regions, includingEurope, Asia, and North America.	The paper highlights the complex and multifaceted nature of the energy crisis, which has been exacerbated by a range of factors, including supply chain disruptions, rising energy demand, and geopolitical tensions. The paper also highlights the potential benefits of transitioning to a more sustainable energy system, including improved air quality, reduced greenhouse gas emissions, and increased energy security
Strategic crisis management in the European Union: The policy landscape."	SAPEA 2022	The method and research design used in the paper are not explicitly mentioned. However, it can be inferred that the paper is a review and analysis of existing policies and practices in the EU regarding strategic crisis management	The paper aims to provide an overview of the policy landscape for strategic crisis management in the European Union. It analyses the key challenges and opportunities faced by the EU in managing crises and highlights the main policy tools and instruments used in this area.	The territorial focus of the paper is the European Union	The paper emphasizes the need for a coordinated and integrated approach to crisis management and the importance of effective communication and collaboration among EU member states. Overall, the paper provides valuable insights into the EU's efforts to manage crises and offers recommendations for improving the effectiveness of its crisis management policies

Strategic crisis management in the European union	SAPEA 2022	This paper is a report that synthesizes the scientific evidence on strategic crisis management in the European Union	The aim of this paper is to provide policymakers with evidence-based recommendations for improving strategic crisis management in the European Union. The report focuses on a range of crisis types, including natural disasters, cyber-attacks, and public health crises, and examines the challenges associated with each type of crisis	The paper has a specific territorial focus on the European Union, as it examines the challenges and best practices for crisis management in this context	The report identifies a number of key challenges facing the EU in managing crises, including the need for better coordination among member states, the importance of risk assessment and scenario planning, and the need for effective communication and engagement with the public. The report also highlights a number of best practices for improving crisis management, such as the use of early warning systems, the importance of clear decision- making processes, and the need for flexible and adaptive response strategies. Overall, the report provides valuable insights into the challenges and best practices for crisis management in the European Union, and offers evidence-based recommendations for policymakers to improve crisis preparedness and response
What the War in Ukraine means for energy, climate, and food	Jeff Tollefson, 2021	The article is a news report and analysis, based on information gathered from various sources such as interviews with experts, official reports, and published research papers	The aim of the article is to examine the implications of the ongoing war in Ukraine on the global energy, climate, and food systems. The author provides an overview of the current situation and analyses the potential consequences of the conflict for various sectors, including energy security, renewable energy, greenhouse gas emissions, and food production.	The territorial focus of the paper is primarily on Ukraine and its neighbouring countries, as well as the impact of the conflict on Europe and the rest of the world	The article highlights several key findings, including the potential disruption of natural gas supplies from Russia to Europe through Ukraine, the impact of the conflict on renewable energy investments and climate targets in the region, the potential increase in greenhouse gas emissions from coal-fired power plants, and the potential disruption of global food supplies due to Ukraine's position as a major exporter of agricultural products. The author also notes that the conflict highlights the vulnerability of global energy, climate, and food systems to geopolitical tensions and the need for greater resilience andcooperation to address these challenges

Energy crisis: five questions that must be answered in 2023	Andreas Goldthau and Simone Tagliapietra, 2022	The article is an opinion piece that does not rely on a specific research method or design.	The aim of the paper is to discuss the current energy crisis and pose five critical questions that policymakers, businesses, and the public must address in order to navigate the challenges ahead	The article discusses the energy crisis on a global scale, with specific reference to Europe, Asia, and the United States.	The authors identify five key questions related to the energy crisis: (1) How can countries balance climate change commitments with the need for reliable energy supply? (2) How can countries manage the transition from fossil fuels to renewable energy sources? (3) How can countries address the vulnerability of energy infrastructure to cyberattacks and other threats? (4) How can countries ensure access to affordable energy for all? (5) How can countries collaborate on energy security in the face of geopolitical tensions? The authors suggest that addressing these questions will require a coordinated, multi-stakeholder approach and proactive policy action.
Best practices in EU crisis response and policy implementation	Jozef Bátora, Steven Blockmans, Enver Ferhatovic, Ingo Peters, Pernille Rieker, Eva Stambøl, Siri Strand 2016	The report describes the methodology used in the research, which includes literature reviews, case studies, expert interviews, andworkshops	The aim of the paper is to provide an analysis of the best practices in EU crisis response and policy implementation. The report provides an overview of the existing literature and the state of the art in the field. It identifies best practices and lessons learned from case studies, expert interviews, and workshops, and provides recommendations for policymakers and practitioners	The paper focuses on the European Union and its crisis response and policy implementation practices	The report identifies several best practices in EU crisis response and policy implementation, including the importance of a coordinated and flexible response, the need for clear communication and transparency, the importance of stakeholder engagement, and theneed for evidence-based policies. The report provides recommendations for policymakers and practitioners, such as the need for greater coordination, the importanceof building trust, and the need for long-term planning and investments.
Understanding the EU's crisis response toolbox and decision-makingprocesses	Jozef Bátora, Steven Blockmans, Enver Ferhatovic, Ingo Peters, Pernille Rieker, Eva Stambøl 2016	The paper is a desk-based study that uses qualitative research methods such as document analysis and literature review. The authors analyse various crisis response tools used by the EU and explore the decision-making processes involved in their deployment.	The aim of the paper is to provide a better understanding of the EU's crisis response tools and decision-making processes. The authors seek to identify the key features and challenges of the EU's crisis response mechanism and suggest ways to improve its effectiveness.	The paper focuses on the European Union's crisis response mechanisms and decision-making process	The authors identify several key features of the EU's crisis response mechanism, including its complexity, flexibility, and interdependence. They also highlight several challenges, such as the lack of coordination among member states, inadequate communication and information sharing, and the politicization of crisis response. The paper suggests several ways to improve the effectiveness of the EU's crisis response mechanism, including enhancing communication and information sharing, improving coordination and cooperation amongmember states, and strengthening the role of the EU institutions in crisis response.

EU general risk assessment methodology (Action 5 of Multi-Annual Action Plan for the surveillance of products in the EU (COM (2013)76	GROW B1 2016	The methodology is based on the best available scientific evidence and considers the uncertainties associated with the riskassessment process. It describes the steps and principals involved in risk assessment, including hazard identification, hazard characterization, exposure assessment, and risk characterization	The aim of the paper is to present the general risk assessment methodology for products in the EU. The paper provides a detailed description of the steps and principals involved in risk assessment and highlights the importance of using the best available scientific evidence in the risk assessment process.	The paper focuses on the EU and its risk assessment methodology for products.	The paper describes the general risk assessment methodology for products in the EU and emphasizes the importance of using the best available scientific evidence. The paper also highlights the need for transparency in the risk assessment process and the importance of involving stakeholders in the decision-making process. Overall, the paper provides a useful guide for conducting risk assessments of products in the EU.
Energy Prices and Crisis Risks	Robert Kahn 2016	The paper employs a qualitative research method	The aim of the paper is to explore the risks that energy price volatility poses to global economic stability and to provide policy recommendations for mitigating these risks	The paper has a global territorial focus	The paper finds that energy price volatility can have significant negative effects on global economic stability, with the potential to cause financial crises and geopolitical instability. The paper recommends a range of policy responses, including diversifying energy sources and promoting energy efficiency, improving market transparency, and developing better international coordination mechanisms for responding to energy price shocks.
Energy efficiency as Europe's first response to energy security	Ingrid Holmes, Luca Bergamaschi, and Nick Mabey and was published in 2014	The paper is a policy report that uses a combination of literature review, case studies, and expert interviews to examine the potential of energy efficiency measures to enhance Europe's energy security	The aim of the paper is to explore the role of energy efficiency in enhancing Europe's energy security, particularly in the face of potential supply disruptions and price volatility. The paper seeks to identify the benefits and challenges of implementing energy efficiency measures and to provide policy recommendations for maximizing the potential of energy efficiency as a response to energy security challenges.	The paper focuses on the European Union (EU) and its member states	The authors provide several policy recommendations for overcoming these challenges, such as establishing ambitious energy efficiency targets, implementing supportive policies and regulations, and enhancing public awareness and engagement. Overall, the paper suggests that energy efficiency should be considered as Europe's first response to energy security challenges, before considering other measures such as increasing domestic production or importing from new suppliers

UK Electricity Market Reform and the Energy Transition: Emerging Lessons	Michael Grubb and David Newbery 2016	The paper uses a combination of quantitative and qualitative methods. It reviews the UK's electricity market reform (EMR) and its effectiveness in facilitating the transition to low-carbon energy	The aim of the paper is to evaluate the effectiveness of the UK's EMR in promoting the energy transition, particularly in reducing carbon emissions and increasing the share of renewable energy in the electricity mix. The paper also aims to identify the emerging lessons from the EMR experience that can inform the design of energy policies and market mechanisms in other countries	The paper focuses on the UK's electricity market and policy context, specifically the EMR that was introduced in 2013 to address the challenges of energy security, decarbonization, and affordability.	The paper finds that the EMR has been successful in increasing investment in renewable energy sources, particularly in offshore wind power, and in reducing carbon emissions from the electricity sector. However, it also highlights some limitations of the EMR, such as its complex design and implementation, high administrative costs, and the lack of incentives for demand-side management and energy efficiency. The authors suggest that the EMR experience offers valuable lessons for other countries in terms of designing effective policies and market mechanisms to support the energy transition
Energy efficiency as Europe's first response to energy security	Ingrid Holmes, Luca Bergamaschi, and Nick Mabey 2014	The paper is a policy brief that analyses the role of energy efficiency in addressing energy security concerns in Europe. The authors use a qualitative approach, drawing on existing literature and policy documents to make their arguments	The paper aims to highlight the importance of energy efficiency as a tool for improving energy security in Europe. The authors argue that energy efficiency measures can reduce the dependence on imported energy, increase energy independence, and lower energy costs for consumers.	The paper focuses on Europe and the European Union, specifically, in addressing the issue of energy security	The authors argue that energy efficiency should be prioritized as the first response to energy security concerns in Europe. They provide evidence to support their claim that energy efficiency measures can increase energy security by reducing the need for imported energy, improving energy independence, and lowering energy costs. The authors also identify policy options and recommendations for promoting energy efficiency in the European context, including regulatory measures and financial incentives
Responding to the UK gas crisis the critical role of energy efficiency and a green home retrofit drive	Colm Britchfield and Pedro Guertler 2021	The paper uses a combination of literature review and analysis to discuss the importance of energy efficiency and green homes retrofit in addressing the UK gas crisis. The authors also draw on expert interviews and case studies to support their argument.	The aim of the paper is to highlight the crucial role that energy efficiency and green homes retrofit can play in addressing the UK gas crisis. The authors argue that investing in these areas can reduce demand for gas and help address concerns around energy security and affordability	The paper focuses on the UK and the current gas crisis that the country is facing.	The paper argues that investing in energy efficiency and green homes retrofit is essential to addressing the UK gas crisis. The authors suggest that these investments can help reduce demand for gas and make homes more energy- efficient and cost-effective to run. The paper also highlights the potential for job creation and economic benefits associated with these investments. Overall, the paper emphasizes the need for a long-term, comprehensive strategy that prioritizes energy efficiency and green homes retrofit as a key component of the UK's energy transition

Addressing the UK's Energy Needs at Speed: Why Energy Efficiency, Electrification and Renewables are theRight Tools for the Job	Euan Graham and Pedro Guertler 2021	The paper appears to be a policy brief or advocacy piece that argues for the adoption of energy efficiency, electrification, and renewable energy in addressing theUK's energy needs. The authors draw on a range of sources, including government reports, academic literature, and industry publications, to support their arguments.	The paper aims to make the case for energy efficiency, electrification, and renewables as the most effective tools for addressing the UK's energy needs in a timely manner. It argues that these solutions offer a more cost-effective, sustainable, and resilient path to meeting energy demand than traditional fossil fuel-based options	The paper focuses specifically on the UK's energy needs, with a particular emphasis on the need to transition away from fossil fuels to address climate change and energy security concerns	The paper presents a series of arguments and evidence to support the adoption of energy efficiency, electrification, and renewables in the UK's energy mix. It highlights the benefits of these approaches, including reduced energy costs, improved energy security, and reduced carbon emissions. It also argues that the adoption of these solutions can create new jobs and stimulate economic growth. Finally, the paper calls for policymakers and industry leaders to prioritize these solutions in their energy planning and investment decisions
Energy Resources and Markets – Perspectives on the Russia–Ukraine War	Johannesson, Jokull; Clowes, David, 2022	The method and research design used in the paper are not explicitly stated. However, it can be inferred that the author conducted a literature review to analyse the impact of the Russia-Ukraine war on the Europeanenergy crisis	The aim of the paper is to explore the impact of the ongoing conflict between Russia and Ukraine on the European energy crisis. The paper aims to identify the reasons for the energy crisis, analyse the impact of the conflict on energy security in Europe, and propose potential solutions to mitigate the impact of the crisis	The paper primarily focuses on Europe and the impact of the Russia-Ukraine war on the European energy crisis	The paper identifies several key factors that have contributed to the European energy crisis, including the disruption of gas supplies from Russia due to the ongoing conflict, the limited diversification of energy sources, and the slow progress in transitioning to renewable energy sources. The paper also highlights the potential consequences of the energy crisis, including economic impacts, political tensions, and risks to energy security. The author proposes several potential solutions to address the crisis, including increasing energy efficiency and conservation, accelerating the transition to renewable energy sources, and improving energy diversification strategies
Indicators for Energy Security	Bert Kruyt, D.P. van Vuuren, H.J.M. de Vries, H. Groenenberg 2009	The specific method and research design used in the paper are not provided in the information given. However, as the paper is published in the journal Energy Policy, it is likely to employ a research methodology that includes a literature review, analysis of existing indicators and frameworks, and potentially the development of new indicators for energy security assessment.	The aim of the paper is to explore the concept of energy security and propose indicators that can be used to assess and monitor energy security. The paper likely seeks to provide a comprehensive framework or methodology for evaluating energy security by identifying key indicators related to various aspects, such as energy supply, infrastructure, geopolitical risks, and market dynamics.	The territorial focus of the paper is not explicitly stated in the provided information. However, it can be inferred that the paper is intended to have a broad scope and can be applicable to different regions and countries. The focus is likely on the conceptual development of indicators rather than specific regional or country-specific analysis.	The specific results and findings of the paper are not mentioned in the provided information. Since the paper is focused on developing indicators for energy security, the findings are likely centred around the proposed indicators and their potential usefulness in assessing energy security. The paper may discuss the relevance and applicability of these indicators, their potential role in policy-making and decision-making processes, and their contribution to understanding and addressing energy security challenges.

A generic framework for the description and analysis of energy security in an energy system"	Larry Hughes 2012	The research design may involve a conceptual analysis of energy security dimensions, identification of key components and interrelationships within an energy system, and the development of a framework that can be applied to various contexts.	The aim of the paper is to present a generic framework for the description and analysis of energy security in an energy system. The paper likely intends to provide a systematic and comprehensive approach to understanding and assessing energy security, considering various factors such as energy supply, infrastructure, demand, vulnerabilities, and resilience. The framework may help. researchers and policymakers analyse energy security challenges, identify potential risks and mitigations, and inform decision-making processes.	The territorial focus of the paper is not explicitly stated in the given information. However, as the paper aims to provide a generic framework, it is likely applicable to various territorial contexts and energy systems. The focus may be on the conceptual development of the framework rather than a specific geographical region or country.	The paper presents the proposed generic framework for describing and analysing energy security in an energy system. It may discuss the key components and interrelationships within the framework and how it can be applied to assess energy security. The paper may also provide insights into the usefulness and applicability of the framework in understanding and addressing energy security challenges.
The concept of energy security: Beyond the four A's	Cherp, Aleh; Jewell, Jessica. 2014	It can be inferred that the paper likely adopts a conceptual approach to analyse the concept of energy security. The authors may conduct a literature review, analyse existing frameworks and definitions of energy security, and propose an expanded understanding of energy security beyond the traditional "four A's" framework (Availability, Accessibility, Affordability, and Acceptability). The research design may involve critical analysis and synthesis of relevant literature and concepts.	The aim of the paper is to explore and expand the concept of energy security beyond the traditional "four A's" framework. The authors intend to provide a broader and more comprehensive understanding of energy security that encompasses additional dimensions, such as environmental sustainability, governance, social acceptance, and long-term resilience. The paper seeks to enhance the understanding of energy security and contribute to the development of more effective policies and strategies in the energy sector.	The territorial focus of the paper is not explicitly stated in the given information. However, as the paper aims to expand the concept of energy security beyond the traditional framework, it is likely applicable to various territorial contexts and energy systems. The focus may be on conceptual discussions and theoretical developments rather than a specific geographical region or country	The specific results and findings of the paper are not mentioned in the given information. However, based on the title and aim, the paper is expected to provide a critical analysis and conceptual framework for understanding energy security beyond the traditional "four As." It may present an expanded set of dimensions or factors to consider in energy security assessments and policymaking. The paper may also highlight the importance of considering broader socio-economic, environmental, and governance aspects in energy security analysis

Germany’s Energy Efficiency Strategy 2050	Federal Ministry for Economic Affairs and Energy, 2019	the paper presents a strategic document outlining Germany's Energy Efficiency Strategy for the year 2050. The document includes policy analysis, expert insights, anda comprehensive review of energy efficiency measures and targets. The research design may involve a combination of literature review, stakeholder consultations, and policy analysis.	The aim of the paper is to present Germany's Energy Efficiency Strategy for the year 2050. The authors, representing the Federal Ministry for Economic Affairs and Energy, likely intend to provide a roadmap and comprehensive plan for achieving energy efficiency goalsin Germany. The paper outline specific targets, policies, and measures that Germany will adopt to enhance energy efficiency across various sectors, such as buildings, industry, and transportation. The aim is to promote sustainable and efficient energy use, reduce greenhouse gas emissions, and contribute to Germany's energy transition.	The territorial focus of the paper is Germany. The Energy Efficiency Strategy is specifically designed for the German context, considering the country's energy landscape, socio-economic factors, and policy frameworks. The strategies and measures proposed in the paper are tailored to address the energy efficiency challenges and opportunities within Germany.	The specific results and findings of the paper are not mentioned in the given information. However, it can be inferred that the paper presents a comprehensive strategy for energy efficiency in Germany, aiming to achieve specific targets and milestones by the year 2050. The findings may include an assessment of the current energy efficiency landscape in Germany, identification of barriers and opportunities, and proposed policy interventions and measures. The paper may also highlight the potential economic, environmental, and social benefits of improving energy efficiency in Germany.
Energy supply security in Germany can be guaranteed even without natural gas from Russia" 2022	Franziska Holz, Robin Sogalla, Christian von Hirschhausen, and Claudia Kemfert	The authors conducted an analysis and assessment of Germany's energy supply security, particularly regarding the dependence on naturalgas imports from Russia. The research design may involve a combination of data analysis, modelling, and policy analysis. The authors may have collected and analysed data on Germany's energy supply sources, including the importation of natural gas, and conducted scenario-based assessments to evaluate the potential impacts of reducing or eliminating reliance on Russian natural gas	The aim of the paper is to demonstrate that Germany can ensure energy supply security even without relying on natural gas imports from Russia. The authors seek to challenge the prevailing assumption that Germany's energy security is highly dependent on Russian natural gas and provide evidence-based arguments for alternative energy supply options. The paper may propose and analyse various scenarios, policy measures, and technologies that can contribute to diversifying Germany's energy sources and reducing dependence on Russian natural gas	The territorial focus of the paper is Germany. The authors specifically examine the energy supply security situation within the context of Germany's energy system and its dependence on natural gas imports from Russia. The findings and recommendations presented in the paper are relevant to the German energy sector.	That Germany has viable alternatives to ensure energy supply security without relying heavily on natural gas imports from Russia. The findings may highlight the potential benefits of diversifying energy sources, including increasing renewable energy generation, improving energy efficiency, and exploring alternative import options. The paper may also provide insights into the potential challenges, costs, and policy implications associated with reducing reliance on Russian natural gas.

What if? The Economic Effects for Germany of a Stop of Energy Imports from Russia	Rüdiger Bachmann, Moritz Kuhn, Andreas Peichl 2022	The authors conducted an economic analysis or modelling exercise to assess the potential effects on Germany's economy if energy imports from Russia were to cease. The research design may involve collecting and analysing relevant economic data, constructing models, and running simulations or scenarios to estimate the economic consequences of such a hypothetical event.	The aim of the paper is to examine the economic effects that Germany would face in the event of a stoppage of energy imports from Russia. The authors seek to provide insights into the potential consequences for Germany's economy, including its industries, households, and overall economic performance. The paper may analyse the direct and indirect impacts on various economic sectors, trade, employment, and income distribution.	The territorial focus of the paper is Germany. The authors specifically analyse the potential economic effects in Germany in the event of a halt in energy imports from Russia. The findings and conclusions presented in the paper are relevant to understanding the economic vulnerabilities and potential risks associated with Germany's dependence on Russian energy imports	The authors examine the potential economic implications of a disruption in energy imports from Russia. The findings may highlight the vulnerabilities and risks that Germany would face, such as higher energy prices, supply shortages, reduced economic output, employment impacts, and potential adjustments required in energy sourcing and consumption patterns. The paper may also discuss policy implications and potential strategies to mitigate the adverse effects on theGerman economy.
Energy Crisis and Structural Change: Prospects for German Industry	German Council of Economic Experts 2022/23	The specific method and research design of the article are not mentioned in the given information. However, as it is an annual report from the German Council of Economic Experts, it is likely that the paper is based on a comprehensive analysis of the energy crisis and its implications for German industry. The research design may involve gathering and analysing relevant economic data, conducting sector-specific assessments, and employing economic models or scenarios to assess the potential impact on German industry.	The aim of the paper is to explore the prospects for German industry in the context of the energy crisis. The authors likely investigate the challenges and opportunities arising from the energy crisis, including its impact on the competitiveness, structure, and sustainability of German industries. The paper may provide policy recommendations and strategic insights to help German industry navigate the energy crisis and facilitate structural changes that support long-term resilience and growth.	The territorial focus of the paper is Germany. The authors specifically analyse the energy crisis's implications for the German industrial sector. The findings and recommendations presented in the paper are relevant to understanding the challenges and opportunities faced by German industries in the context of the energy crisis.	The specific results and findings of the paper are not mentioned in the given information. However, it can be inferred that the authors examine the potential impacts of the energy crisis on German industry. The findings may cover a range of aspects, including the effects on energy-intensive sectors, technological innovations, workforce transitions, and policy measures to promote sustainable and competitive industrial development. The papermay also highlight the need for structural changes, investment in renewable energy, energy efficiency measures, and adaptation strategies to mitigate the impacts of the energycrisis on German industry

Responses to the Energy Crisis: The Cases of Germany, France, Italy, and Spain"	Torres Raymond, 2022	The paper involves a comparative analysis of the responses to the energy crisis in Germany, France, Italy, and Spain. The research design may include a combination of qualitative and quantitative methods, such as literature review, case studies, data analysis, and policy analysis.	The aim of the paper is to examine and compare the responses of Germany, France, Italy, and Spain to the energy crisis. The authors likely investigate the strategies, policies, and measures implemented by these countries to address the challenges posed by the energy crisis. The paper may analyse the effectiveness and outcomes of these responses, identifying best practices and lessons learned. The aim could also include identifying commonalities and differences in the approaches taken by these countries.	The territorial focus of the paper is Germany, France, Italy, and Spain. The authors compare the responses of these four countries to the energy crisis, providing insights into the specific measures and policies adopted by each country	The authors provide a comparative analysis of the responses to the energy crisis in Germany, France, Italy, and Spain. The findings may include an assessment of the effectiveness of different policy measures, the impact on energy security and sustainability, the role of renewable energy and energy efficiency, and the challenges faced by each country in managing the energy crisis. The paper may also highlight successful approaches and policy recommendations for addressing the energy crisis in these countries.
Tackling the UK's Energy Efficiency Problem: What the Truss Government Should Learn from Other Countries	Rosa Hodgkin and Tom Sasse 2022	The paper involves a policy analysis and comparative study. The authors may have conducted a literature review, examined case studies, and analysed policy approaches from other countries to address energy efficiency issues. The research design could include qualitative and quantitative methods, such as data analysis, policy evaluation, and expert interviews.	The aim of the paper is to address the energy efficiency problem in the UK and provide insights and recommendations based on the experiences of othercountries. The authors likely examine the policies and practices of other countries that have successfully tackled energy efficiency challenges, aiming to identify lessons and strategies that the UK's Truss Government can learn from. The paper may explore innovative approaches, policy frameworks, and governance models that can be adapted to enhance energy efficiency in the UK.	The territorial focus of the paper is the United Kingdom. The authors specifically analyse the energy efficiency problem within the UK context and propose recommendations for the Truss Government.	The findings may include a comparative assessment of energy efficiency policies and practices, identification of successful strategies and implementation challenges, and policy recommendations tailored to the UK context. The paper may highlight the importance of political will, effective governance structures, financial incentives, and public engagement in addressing the energy efficiency problem.

Energy Supply Security Can Be Guaranteed Even Without Natural Gasfrom Russia	Franziska Holts, Robin Sogalla, Christian Von Hirschhausen 2022	The paper involves an analysis of energy supply and security. The authors conducted a literature review, examined data on energy sources and infrastructure, and analysed various scenarios and policy options. The research design includes quantitative analysis, modelling, and policy evaluation.	The aim of the paper is to explore the possibility of ensuring energy supply security without relying on natural gas imports from Russia. The authors investigate alternative energy sources, infrastructure developments, and policy measures that can enhance energy supply diversification and reduce dependence on Russian gas. The paper may aim to provide insights and recommendations for policymakers and stakeholders in the energy sector.	Germany	The authors argue that energy supply security can be achieved even without relying on natural gas imports from Russia. The paper present evidence and analysis demonstrating the feasibility and benefits of diversifying energy sources, enhancing energy efficiency, and promoting renewable energy technologies. The findings include policy recommendations for policymakers and stakeholders to reduce dependence on Russian gas and ensure energysupply resilience.
Managing the Energy Crisis in Solidarity and Shaping the New Reality	German Council of Economic Experts 2022/23	The article appears to be a combination of economic analysis, policy recommendations, and insights from the German Council of Economic Experts. It likely involves a combination of data analysis, economic modelling, and expert opinions.	The aim of the paper is to address the impact of high energy prices on the German economy and provide recommendations to alleviate the burden on households and businesses. It emphasizes the need for targeted measures to address the energy shortage and reduce dependencies in the context of a changing geopolitical environment. The paper aims to inform policymakers and stakeholders about the necessary actions to manage the energy crisis and navigate the challenges posed by high energy prices.	Germany	The specific results and findings of the article are not provided in the given information. However, based on the content, it can be inferred that the article highlights the negative impact of high energy prices on the German economy, including reduced GDP growth and increased inflation. It emphasizes the need for expanded energy supply, increased energy savings, targeted relief measures for households and firms, and measures to reduce dependencies and improve supply chain resilience. The article also highlights the importance of addressing the shortage of skilled workers through labour migration, continuing education, and training initiatives.

Energy Crisis and structural change: Prospects for energy crisis	German Council of Economic Experts 2022/23	It appears to be an analysis or commentary on the current economic situation in Europe, specifically regarding the sharp increase in wholesale prices for energy carriers.	The aim of the study is to address the recent sharp increase in wholesale prices for energy carriers in Europe and its impact on the economy, particularly in Germany. It discusses the consequences of high energy prices on different sectors and the need for short-term and medium-term measures to reduce energy costs, expand energy supplies, and enhance competitiveness through low-carbon energy sources.	Germany	To address the energy crisis, the government is formulating short-term measures aimed at alleviating energy costs. These measures include proposing price ceilings on gas and electricity to maintain energy-saving incentives and prevent gas shortages. Additionally, efforts are being made to expand energy supplies where feasible, with the objective of lowering prices. Unlike measures implemented during the COVID-19 pandemic, the focus is not solely on maintaining the status quo but rather on supporting companies with viable medium- and long-term business models in Germany and Europe

Note: Source, Galue and Obinna (2023)