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Climate and Energy: A Perfect Match?

An Analysis of the Potential Impacts of the EU Emissions Trading System (EUETS) on European Energy Security

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Abstract

Energy security and climate change are prime political concerns in the European Union. The main instrument to combat climate change through reducing greenhouse gas emissions in the EU is the EUETS, a cap and trade system. This thesis investigates in a case study the question of how the EUETS potentially impacts European energy security. In order to analyze potential impacts, this study operationalizes theories of institutional interaction and of energy security. Using a literature review method, the energy security impacts of the five main climate mitigation options that operators under the EUETS have, are analyzed: switch to natural gas, switch to renewables, switch to nuclear, energy efficiency improvements and carbon capture. The analysis shows that the potential impact on European energy security is different for each option. The EUETS as a whole therefore has a potentially mixed impact on energy security. More research is needed in order to assess the actual rather than only the potential impacts of the EUETS on energy security. For such research to be feasible, governments must begin to collect and publish data on emissions abatement under the EUETS, so that researchers can observe what operators actually do to reduce their emissions.

Key words: European Climate Policy, Energy Policy, Energy Security, Emissions Trading System, Institutional Interaction,

Words: 19996

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List of Abbreviations

CCS	Carbon Dioxide Capture and Storage
CEP	Climate and Energy Package
CFSP	Common Foreign and Security Policy (of the EU)
CM	Climate Mitigation
CPI	Climate Policy Integration
DG	Directorate-General (of the European Commission)
EC	European Commission
ECSC	European Coal and Steel Community
EE	Energy Efficiency
EEC	European Economic Community
EES	European Energy Security
ES	Energy Security
ETS	Emissions Trading System
EU	European Union
EU-27	The European Union of 27 Member States (2007 - 2013)
EUA	European Union Allowance
EUETS	European Union Emissions Trading System
EPI	Environmental Policy Integration
EURATOM	EAEC - European Atomic Energy Community
GHG	Greenhouse Gas
IPCC	Intergovernmental Panel on Climate Change
KP	Kyoto Protocol
LNG	Liquefied Natural Gas
MAC	Marginal Cost of Abatement
MRV	Monitoring, Reporting and Verification (of GHG emissions)
MS	Member States (of the European Union)
NAP	National Allocation Plan
NPP	Nuclear Power Plant
OECD	Organization for Economic Cooperation and Development
PPP	Polluter Pays Principle
QMV	Qualified Majority Voting
RES	Renewable Energy Source(s)
RES-E	Renewable Energy Source(s) for Electricity
SEA	Single European Act (1986)
TEU	Treaty on European Union (2009)
TFEU	Treaty on the Functioning of the European Union (2009)
UNFCCC	United Nations Framework Convention on Climate Change
tCO_2e	Ton of Carbon Dioxide Equivalent
WTO	World Trade Organization

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1 Introduction

1.1 Background

Climate change is often described as one of the most severe threats that mankind has ever faced, and at the same time one of the most difficult ones to defuse (Munasinghe & Swart, 2005:3, 208; Greenpeace, 2013). It is caused by the release of greenhouse gases (GHG) into the atmosphere, a ubiquitous occurrence in today's technological civilization (ibid:14). In 1992 the signatory countries of the United Nations Framework Convention on Climate Change (UNFCCC) agreed that the most developed countries have a special responsibility to stop climate change because they have emitted GHGs for the longest time, because their per capita emissions are among the highest in the world, and because they have the biggest capacity to mitigate ("Principle of Common but Differentiated Responsibilities" UNFCCC, 1992, Art. 3§1, Art.4§2). The scientific research synthesized by the Intergovernmental Panel on Climate Change (IPCC), the international scientific body tasked with compiling research on climate change, estimates that in order for climate change not to become catastrophic, world GHG emissions need to be reduced by 50% - 80% by the year 2050 compared to 1990 levels (IPCC, 2007:197).

Because of the special responsibility of developed countries to mitigate climate change stated in Art. 3§1 UNFCCC, it is necessary that the EU and other highly developed countries and regions[1] reduce their respective emissions by 80% - 95% by 2050 in order to reach the overall world-wide emissions reductions goal of 50% - 80% (IPCC, 2007:776). In 2009 the EU took a bold first step by adopting the climate and energy package (CEP), which includes a binding commitment to reduce GHG emissions by 20% by the year 2020 and to increase the reduction to 30% if other developed countries followed (Egenhofer&Alessi, 2013:2). The EUETS (European Union Emissions Trading System) is the flagship instrument of the CEP, it covers some 11 000 large industrial installations and power plants, which produce ca. 45% of all European GHG emissions (European Commission, 2013e:2-4). It is a market-based instrument that issues emission permits every year for the amount of GHGs that can be safely released into the

[1] Highly developed countries in this context refers to the Annex-1 countries of the UNFCCC (1992:23)

atmosphere, which the installations covered by the EUETS directive (2009/29/EC) must purchase at auctions in order to be able to emit[2] (ibid). The EUETS promises to reduce emissions at the lowest possible cost thanks to efficient allocation by market mechanisms. It also provides flexibility to individual installations, which can decide individually whether to reduce emissions (abate) or rather buy permits and emit, and if they abate the choice of how to abate and of how much is also left to them. While being designed with a focus on flexibility and economic efficiency, the effects of the EUETS on European energy security (EES) are less well-known and understood.

Energy security (ES) is a large and growing concern for Europe, mainly because of Europe's dependence on imported energy (European Commission, 2010:2-5). In 2010, the EU needed to import 52,7% of all the energy it consumes from outside the Union, mostly in the form of coal, oil, and gas (Eurostat, 2012:29). The rise of energy prices to unprecedented levels during the first decade of the 21st century (ibid) as well as several interruptions of gas deliveries from Russia to Europe in the middle of the winter (Pirani et al., 2009:19), firmly established the issue of ES on the agenda of politicians and in public perception alike (Smith-Stegen, 2011:6506). Reflecting the rise in importance of ES, starting in the year 2000, the European Commission published a series of green papers, communications and other policy documents (cf. Checchi et al, 2009:5; European Commission, 2000), culminating in the inclusion of energy security as a goal for European energy policy in the treaty of Lisbon (Art. 194§1(b) TFEU). Many consider energy security as well as climate policy as some of the most important and prioritized issues in EU policy today and for a long time to come (Langsdorf, 2011:2).

The link between the EUETS and EES are fossil fuels (IEA, 2007:28). When fossil fuels are burned, CO_2, which is a GHG, is emitted into the atmosphere and contributes to climate change (Munasinghe & Swart, 2005:14). What makes the overlap especially salient is the fact that CO_2 emissions from the combustion of fossil fuels make up 77% of total anthropogenic GHG emissions and CO_2 is thus the most important radiative forcing agent causing climate change (IPCC, 2007:103). At the same time, fossil fuels are also by far the most important energy source of the EU, representing 77% of gross inland energy consumption[3] of the EU-27 in 2010 (Eurostat, 2012:40). Climate policies directly or indirectly influence fuel choices away from high-carbon and towards low-carbon or no-carbon energy sources (IEA, 2007:38). This is also the case for the EUETS, which puts a price on carbon, i.e. an economic disincentive to use carbon-rich fuels and thus abate emissions. Abatement, i.e. technology applied or measures taken to reduce emissions (Thampapillai, 2002:113), almost always causes changes in fossil fuel consumption. As a result of abatement either less fossil fuels are consumed because abatement activities mean more efficient equipment is used, or

[2] A more detailed description of the EUETS is given in chapter 2.
[3] Gross Inland Energy Consumption is a comprehensive statistical measure for energy consumption. 2010 is the latest year that data has been published for at the time of writing.

fuel is changed for less carbon-intense sources. Both types of change are assumed to have an impact on ES (IEA, 2007:91).

The EUETS sector consists of large installations like power plants or large industrial plants and emits 45% of all GHG emissions in the EU (European Commission, 2013b). The share of EUETS emissions that originate from the combustion of fossil fuels is 73% (EEA, 2013:21). Most of these emissions come from electricity generation in fossil fuel power plants and from industrial and district heating plants[4] (ibid:30).

1.2 Research Problem

In climate and energy policy circles, there is an ongoing debate about the relationship between climate policies and energy security (cf. Sovacool, 2010:44-46; Checchi et al, 2009:42; Turton&Barreto, 2006:2246-2248). Some authors, especially those advocating climate mitigation policies, argue that climate mitigation policies such as the EUETS are improving European energy security (EES) because they reduce the reliance on imported fossil fuels (cf. McCollum et al., 2013:486-488; IPCC, 2014b:45). Other authors argue that climate mitigation policies make energy more expensive because they make cheap and plentiful domestic coal unusable (cf. Adelle et al., 2009:42-44; Checchi et al. 2009:42) and that the purported benefits for EES are less than certain (Luft et al. in Sovacool, 2010:48-51). These claims are usually based on some improvised arguments rather than being based on a comprehensive analysis of the EUETS. Several analyses of the EUETS economic and environmental impact have been published (European Commission, 2008b), but no dedicated analysis of the EES impacts of the EUETS could be found in the literature search for this study. A report jointly published by FRIDE, a Spanish think tank and Egmont, the Royal Belgian Foreign policy think tank, highlights the same point: “This author found no comprehensive study of the current or potential net impact of the ETS on European energy security” (Gault, 2007:3). Adelle et al. (2009:16) also identify a clear need “ [...] to more widely examine the possible synergies and trade-offs between climate and energy policy”. Also Martin et al. (2012:46) identify a clear research gap on the question of how the EUETS interacts with existing policies and policy goals. Both climate mitigation and ES are important and overlapping European policy concerns, whose importance is expected only to increase in the future (Langsdorf, 2011:2). There is a chance that the EUETS will affect the achievement of EES, but at this point we do not have a clear picture of how it may do so, whether the impact will be positive or negative, or if there is going to be a noticeable impact at all.

[4] i.e. “combustion installations” in the language of the EUETS directive (2009/29/EC:85)

Because of the great importance of both climate mitigation policy and energy security for the EU, as well as the perceived research gap about the nature of the relationship between the two policies, I propose the following research question:

How does the EU ETS potentially affect European energy security?

Sub-question:
How do the different abatement options available to operators under the EUETS potentially influence European energy security?

In order to answer the research question I conduct an exploratory qualitative case study, where the potential impacts of the EUETS on EES are treated as cases of institutional interaction. To find out what kind of effect the different abatement options potentially have on EES I propose to structure the thesis in the following way:

In chapter two the policy context of the EUETS and of European energy security, i.e. European climate policy and European energy policy, is introduced. This overview of the policy context shall enable the reader to better understand and place in its context the more specific analysis of ES impacts, which is performed in chapter five. Also in chapter two, in section 2.1.3, the five climate mitigation options compiled by the IPCC are identified as the aspect (outcomes) of the EUETS most likely to affect EES, and which are therefore specifically mentioned in the sub-question.

In order to conceptualize how one policy such as the EUETS may influence or affect another policy or policy goal such as EES, the framework of institutional interaction, developed by Oberthür&Gehring (2006), is discussed and operationalized in chapter three. The framework of institutional interaction also provides a way to categorize the impacts that the EUETS potentially has on EES.

In order to assess what kind of impact an abatement category may have on ES, a sufficiently operational definition of ES is needed. In the second part of chapter three, ES is defined as a function of availability, accessibility and reliability of energy supplies, and arguments are presented for why this specific conceptualization is chosen. The methodological challenges of analyzing institutional interaction through a literature review method are discussed in chapter four.

In chapter five the analysis of how each abatement category may influence EES is performed. First, a description of how each abatement category works, how it achieves climate mitigation, is provided. This is directly followed by an analysis of the potential impacts of the respective abatement option on EES based on a literature review of existing scientific studies and grey literature.

Why are we investigating potential rather than actual effects? Because data availability on actual abatement under the EUETS is poor[5]. Data on abatement is

[5] Section 2.1.3 discusses in more detail the lack of available data on abatement under the EUETS

not collected by governments under the EUETS (Martin et al., 2012:43), and therefore this study focuses on what operators under the EUETS potentially can do to reduce their emissions rather than on what they actually do.

This study focuses on the EUETS as it is in force at the time of writing. This means the rules, which entered into force at the beginning of the third trading period on the 1st of January 2013.

2 Policy Context

The overview of the policy fields given in this chapter shall enable the reader to put the more specific analysis of ES impacts performed in chapter five, into the broader climate and energy policy context, and thus make it accessible and meaningful. The development, theory and functioning in practice of the EUETS as well as an overview of the ES situation and policy in place in the EU are therefore briefly introduced in this chapter.

2.1 The EUETS

2.1.1 Development of the EUETS

During the course of the 1990s European politicians became increasingly aware of climate change (Wråke et al, 2012:12). The understanding that total global emissions need to be reduced in order to avert catastrophic climate change, lead to the 1997 Kyoto Protocol of the UNFCCC (Oberthür & Roche Kelly, 2008:36). The EU and its then 15 member states acted as leaders of the international climate negotiations, urging developed countries to commit to binding emissions cuts, and accepting to make the deepest emissions cuts of all countries[6] themselves (ibid).

After a period of relatively high ambition but little concrete action, the Kyoto protocol commitments, which required the EU to show "demonstrable progress" by 2005 towards achieving their 2012 emissions reduction target of 8%, forced the EU into action (Wråke et al, 2012:13). The joint fulfillment option allowed the EU to pool their emissions reductions, as long as the total would be 8% compared to base year levels, which opened the door for Europe-wide measures to achieve emissions reductions (UNFCCC, 1998, Art. 3). Initially a European tax on emissions was considered as a policy instrument by the Commission, but ran into resistance from member states and the unanimity requirement for matters concerning taxation[7] (Wråke et al, 2012:12; Oberthür & Roche Kelly, 2008:39). An emissions trading system on the other hand was considered environmental

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[6] EU joint commitment to reduce emissions by 8% by the year 2012, compared to 1990 levels (UNFCCC, 1998, Annex B)
[7] The legal base concerning taxation was Art. 93 Amsterdam treaty, which was in force at the time, equivalent to Art. 113 TFEU (Lisbon treaty, EU, 2010)

policy and therefore subject to qualified majority voting rules in the council[8] (Wråke et al, 2012:12). Furthermore, "flexible mechanisms" such as an ETS were specifically included in the Kyoto Protocol and therefore likely to be regarded as "demonstrable progress" towards achieving the required GHG reductions by the UNFCCC (ibid). The EUETS came thus into being after the council adopted directive 2003/87/EC in 2003. The development of the EUETS took place in three phases or trading periods: phase 1 (2005-2007), phase 2 (2008-2012) and phase 3 (2013-2020). Phase one was the pilot phase, it was meant to achieve political buy-in with the participating countries and to generate experience in the operation of the system (Wråke et al, 2012:13). Importantly, phase one and two had national allocation plans (NAP), which allowed national governments to allocate allowances to important industries in their respective countries for free.

The provisions from the "new" EUETS directive (2009/29/EC) that entered into force at the start of the third trading period on January 1st 2013, introduced auctioning as the main method of allocation, and a single European-wide cap (limit) determined by the Commission rather than the NAPs (Wråke et al, 2012:19). Already in 2013 more than 40% of allowances are auctioned. Auctioning will progressively increase to 100%, at the latest by 2027 (European Commission, 2013f). Those allowances still being allocated for free, are allocated according to precise, uniformly applicable rules, chiefly to operators on the carbon leakage list, i.e. installations that are particularly vulnerable to price competition from GHG-intensive products originating in non-ETS countries (Article 10b, Directive 2009/29/EC). Auctioning is important as theorists consider auctioning the economically efficient and fair method of permit allocation (Asafu-Adjaye, 2005:86).

In April 2009 the EU adopted the "Climate and Energy Package" (CEP), which consists of four principal legislative elements: the "renewables directive"[9], the "effort sharing decision"[10], the "new EUETS directive"[11], and the "CCS directive"[12]. Energy efficiency, which is also considered an important part of EU climate policy, was only addressed by a directive[13] in 2012, with energy efficiency targets not binding on MS. The CEP is most well-known for its 20-20-20 targets: 20% emissions reductions (binding), 20% renewable energy sources as share of primary energy consumption (binding), 20% reduction of primary energy consumption (non-binding), all three to be achieved by the year 2020 (Egenhofer&Alessi, 2013:2; European Commission, 2013a).

Boasson & Wettestad (2013:43-50) assess that the EU was eager to demonstrate climate policy leadership ahead of the COP 15 meeting in Copenhagen in 2009, where it wanted to produce successor agreement to the

[8] The legal base for environmental policy was Art. 175 requiring only Art. 251 codecision procedure (Treaty of Amsterdam). Equivalent to Art. 192 and Art. 294 TFEU(Lisbon treaty, EU, 2010)
[9] Directive 2009/28/EC "renewables directive"
[10] Decision 406/2009/EC "effort sharing decision"
[11] Directive 2009/29/EC "new EUETS directive"
[12] Directive 2009/31/EC "CCS directive"
[13] Directive 2012/27/EU "Energy Efficiency Directive"

Kyoto Protocol. It was thought that adopting a strong climate policy unilaterally would give the EU credibility and leverage at the negotiating table (ibid).

2.1.2 Functioning of the EUETS

The EUETS is today (2013) the centerpiece of EU climate mitigation policy and covers around 45% of all GHG emissions in the EU, which it reduces by more than 21% by the year 2020 compared to 2005 levels (European Commission, 2013b). It is a truly European policy as it is uniformly and equally applied to all operators that are included in the EUETS, regardless of MS (ibid; Wettestad et al., 2012:75). Under the EUETS one ton of CO_2 emissions or its equivalent in other GHGs (tCO_2e) equals one allowance (EUA). One tCO_2e contributes to global warming by the same amount, regardless by whom or where[14] it is emitted. Allowances (EUAs) are issued by the EU, and the number of EUAs issued annually is determined by the cap[15]. The cap is another word for the total amount of allowances issued during one year, and thus constitutes an absolute limit on how many tCO_2e can be emitted by all operators together under the EUETS in one year[16] (European Commission, 2013c). It is calculated by taking into consideration the historical emissions of the installations covered by the EUETS directive (2009/29/EC, Art. 9) and the reduction needed to reach the 21% reduction target by 2020 in a linear fashion. After 2013, the cap is reduced every year by the same amount[17]. The idea behind this linear reduction factor is to eliminate the political wrangling that had previously surrounded the setting of the cap, and thus to reduce the impact of political uncertainty on EUA prices (European Commission, 2008a:90-95). Because the cap and its future reductions are known for the entire third trading period, carbon prices are expected to fluctuate less, which should allow participants of the EUETS to better plan their abatement (ibid). Operators of installations covered by the EUETS must surrender one allowance for each tCO_2e they emit. An operator may receive EUAs as free allocation or in an auction from the EU, or from trade with firms who sell their surplus allowances because it is cheaper for them to abate and sell then to emit. If operators do not surrender enough allowances to cover all their emissions, they are fined 100€/tCO_2e unlawfully emitted[18], and have to buy EUAs for the shortfall (European Commission, 2013e:4).

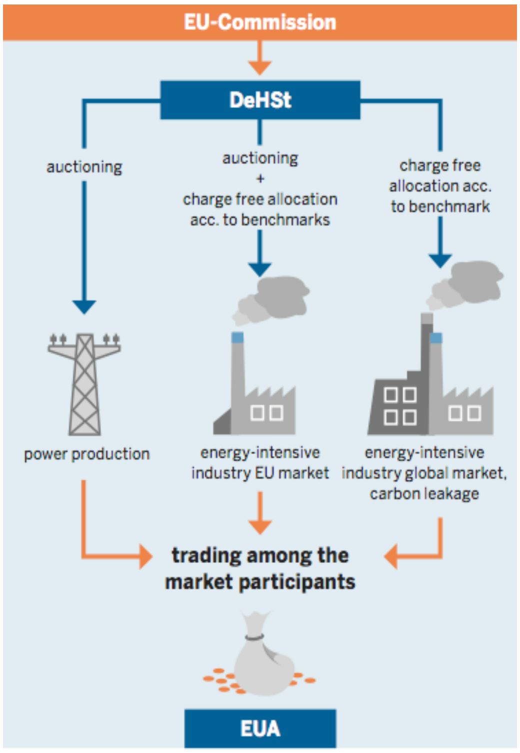
Only large installations are covered by the ETS directive, so that small emitters of GHG are not confronted with an undue administrative or financial

[14] The exception is emissions from aviation, where 1 tCO_2 has a stronger effect on the climate when it is released in the stratosphere, than when it is released near the surface of the earth (IPCC, 2007:49).
[15] Hence the name cap and trade system
[16] For 2013, the first year with a European-wide cap, the number of allowances issued is just under 2.08 billion (European Commission, 2013c).
[17] Linear reduction factor of 37,435,387 allowances, 1.74% of the 2008-2012 average total cap (European Commission, 2013c).
[18] Compare the 100€/ton fine in 2013 to the current market price of ca. 5€/EUA (http://www.investing.com/commodities/carbon-emissions)

burden. The thresholds for participation are laid out in the EUETS directive (2009/29/EC, Annex 1).

In order for the carbon market to work, the number of allowances issued must be inferior to the amount of GHGs that all installations under the EUETS combined would emit without any policy in place[19], thus creating scarcity. Because EUAs are scarce, and because they are tradable on different markets, the demand by operators for EUAs sets a price for the EUA. In theory the price for an EUA equals the aggregate marginal cost of abatement (Thampapillai, 2002:119; Perman, 2011:204). Through the operation of an ETS, those operators for whom it is the cheapest to reduce emissions will abate more and, and those for whom it is more expensive to do so will instead buy permits rather than all being forced to abate by the same amount (cf. Pearce & Turner, 1990:112; Thampapillai, 2002:119; Perman, 2011:204), thus reducing emissions in the most cost-efficient way (European Commission, 2013e:5). What is important for averting catastrophic climate change, is reaching the aggregate reductions targets, i.e. reducing the total amount of GHG emissions, not that every operator reduces them by the same amount (gov.uk, 2013:2).

Figure 1. Functioning of the EUETS



Source: Energieagentur NRW (2013:3)

The carbon price signal is supposed to guide investment decisions of companies into abatement technologies. Cap and trade belongs to a class of environmental policies called market-based instruments (MBI), which use price or some other economic variable to incentivize polluters/economic agents to abate pollution, and thus internalize an externality (Asafu-Adjaye, 2005:86; Saunier & Meganck, 2007:185). The economic/policy motivation behind creating a cap and trade mechanism is to internalize a negative externality, e.g. the GHG emissions causing climate change, and thereby remedying a market failure. When permits (EUAs) are auctioned in the EUETS, the "polluter pays principle" (PPP) is put in practice (European Commission, 2013e:3). The PPP proposes that externalities are internalized at the point where they occur, i.e. by the polluter, thus correcting the market failure in the most accurate way (Asafu-Adjaye, 2005:86). It basically means that: "... polluters should pay for pollution prevention and control measures as well as for the environmental damage they cause and that the government should not subsidize pollution" (Woerdman et al, 2008:572).

[19] This is often referred to as BAU - business as usual scenario

Compliance is ensured through the monitoring, reporting and verification (MRV) cycle, where operators must continuously monitor their emissions, draw up annual emissions reports, have them verified by an accredited verifier, and submit them for further inspection to the competent national authority (European Commission, 2013d). When the MRV cycle is completed, the surrendered allowances are obliterated in the single EU registry. The MRV cycle ensures, that every emission of GHG by every operator is accounted for. It forms the backbone of the EUETS. Only if there is no way to “cheat” i.e. to emit GHGs without anybody noticing, can there be scarcity in the market for EUAs so that they achieve a market value (Brunner et al, 2009:13).

Extending today’s linear reduction factor of the EUETS of 1,74% all the way to 2050, it can be calculated, that the resulting emissions reductions amount to only about 70% reductions compared to 1990-levels (European Commission, 2012:8), far short of the long-term goal of 80% - 95% emissions reductions which EU MS have pledged in the October 2009 Council conclusions (European Council, 2009:3), which are re-confirmed in the energy roadmap 2050 (European Commission, 2011:3) and were originally laid out in the fourth assessment report of the IPCC (2007:776). The cap is thus set at a sub-optimal level and unless it is tightened in the future, the EUETS is actually not effective in preventing catastrophic climate change because it does not produce the required emissions reductions.

2.1.3 Abatement

In environmental economics the term abatement or pollution abatement is often used (cf. Thampapillai, 2002:113). Pollution abatement is defined by the OECD as “... technology applied or measure taken to reduce pollution and/or its impacts on the environment.” (OECD, 2014). Only emissions reductions that are the result of specific efforts to reduce emissions, and not emissions reductions that are caused by other random occurrences like for example an economic crisis, can be counted as abatement (Venmans, 2012:5496). In the case of the EUETS, the pollution that is to be abated is the emission of GHG into the atmosphere (Munasinghe & Swart, 2005:14). As we know from the introduction, the emission of GHG is a special kind of pollution because it causes anthropogenic climate change (ibid). The international scientific body charged with the study of climate change, the IPCC has devised a terminology that is widely followed in the field, using the term “mitigation” to denote “...the effort to control the human sources of climate change and their cumulative impacts, notably the emission of GHGs and other pollutants, such as black carbon particles, that also affect the planet’s energy balance.” (IPCC, 2014a:6).

While the term abatement is obviously broader than the term mitigation because it is also concerned with reducing other kinds of pollution than GHG emissions, it is also more concrete. It speaks of concrete technical measures taken by polluters, whereas climate change mitigation denotes a macro-level effort that is conducted through policies. There is an almost infinite number of technical measures or behavioral changes that an operator can take in order to reduce emissions. Analyzing such individual abatement measures would burden the analysis with too much detail when assessing the effect of the EUETS as a whole on EES. Based on the climate mitigation options suggested by the IPCC, abatement measures are therefore grouped into classes of abatement options. For the remainder of this study I therefore use the terms “mitigation option”, “abatement category” and “abatement option” interchangeably to denote the five categories given below.

The energy sector, which includes extraction, conversion, storage and transmission of energy, is the largest contributor to climate change with approximately 35% of total anthropogenic GHG emissions in 2010 (IPCC, 2014b:7), and the industry sector, which is mostly concerned with the conversion of natural resources into materials, is the second largest contributor to climate change with ca. 30% of total anthropogenic GHG emissions (IPCC, 2014d:8). The coverage of the EUETS overlaps to a large extent with those two sectors: it covers large industrial installations and power generation[20] (i.e. power plants) (cf. EEA, 2013:21). While it is not an exact overlap because e.g. energy transmission or smaller industrial installations lie outside the scope of the EUETS (cf. Directive 2009/29/EC, Annex 1), we assume that the main climate mitigation options that the IPCC compiled for the energy and industry sectors, nevertheless apply to the installations covered by the EUETS. The IPCC suggests that the emission reduction options in the energy sector consist mainly of switching from high-carbon to low-carbon or no-carbon energy sources, while options in the industrial sector are mainly increasing energy efficiency of industrial processes, and switching to low-carbon energy carriers (e.g. electricity from renewable sources) (IPCC, 2014c:84). For the energy and industry sectors, the IPCC thus compiled five concrete climate mitigation categories:

- Switch to RES (renewable energy sources) (IPCC, 2014b:21-22)
- Switch to gas (ibid:19)
- Switch to nuclear (ibid:23-25)
- Use of CCS (carbon dioxide capture and storage) (ibid:25-27)
- Energy efficiency improvements (IPCC, 2014d:20)

The problem with emissions abatement under the EUETS is that, even though it is the desired outcome of the policy, no systematic data collection is performed by official bodies (Martin et al., 2012:43). The few existing studies on abatement under the EUETS rely largely on econometric modeling, comparing the actual emissions under the EUETS to so-called hypothetical/counterfactual/business-as-

[20] the EUETS also covers aviation inside the EU, but the total effect in terms of GHG reductions of aviation-based emissions is rather small compared to the industrial and energy sectors, and it is also unclear whether the inclusion of aviation will be continued (European Commission, 2013g), and I therefore do not consider the aviation sector in this study.

usual projections of how emissions would have developed without the EUETS (cf. Laing et al., 2013:6-8; Ellerman & Buchner, 2008:277-280). Only Point Carbon, a consultancy, appears to directly analyze abatement behavior by surveying companies, however the evidence is anecdotal (Laing et al., 2013:7; Point Carbon 2009).

Another way to infer abatement choices would be to analyze energy consumption patterns of operators under the EUETS. Despite relentless and time-consuming searches, I could not find data on neither the amount nor kind of fossil fuels that the installations covered by the EUETS consume. I could thus not find any data that would link CO_2 emissions in the EUETS to more specific fuels like oil, gas or coal, rather than just to fossil fuels in general as is done in the annual progress reports published by the EEA (cf. "combustion" EEA, 2013:21). As far as I can tell, fuel consumption statistics specifically for the EUETS sector are not published separately. This is a pity because fuel consumption statistics for the EUETS sector could make visible the EUETS's effect on fuel choices, and thus on ES. Fuel consumption data for the EUETS sector would also allow us to know how large the share of the EUETS is relative to total fossil fuel consumption in the EU. As long as we do not know the changes in energy consumption that were made under the EUETS, we cannot analyze their impact on ES or attempt to relate them to abatement choices. What is even more frustrating is that almost all CO_2 emissions under the EUETS are calculated from fuel consumption, using the calculation-based method of the EUETS directive (Art. 21, Commission Regulation 601/2012). Hence fuel consumption data for the EUETS are collected, because CO_2 emissions are calculated from how much fuel an installation consumes, but they do not seem to be published anywhere. The lack of available data on actual abatement behavior also creates a problem when attempting to attribute causality. In the absence of abatement data, how can we be sure, that the emission reductions that took place, were actually caused by the EUETS, and not by e.g. the financial and economic crisis which depressed output?

2.2 Policy Background of Energy Security

ES is nowadays an important policy concern for the EU, so important that it is even a stated goal[21] of EU energy policy in the Lisbon treaty (Art. 194§1(b) TFEU, EU, 2010). In this thesis, energy security (ES) is defined as *a function of availability, accessibility, and reliability of energy supplies*[22].

[21] Article 194§1(b) TFEU (EU, 2010): "...Union policy on energy shall aim, in a spirit of solidarity between Member States, to: ... (b) ensure security of supply in the union"
[22] For a more detailed discussion of ES and its constitutive concepts, see section 3.2.

2.2.1 European Policies with a Bearing on Energy

The heading already announces it to the attentive reader: there is no common European energy policy in the same sense that there is a Common Agricultural Policy (CAP) etc. Instead there are several fragmented policies with varying degrees of priority and varying degrees of impact on energy (Andoura, 2010:69). With the exception of some narrow provisions in the Euratom treaty, energy was never awarded the status of a "common" policy with its own legal basis in the treaties as in agriculture, the internal market or the customs union (Adelle et al., 2009:18; Nilsson, 2011:1509, Andoura, 2010:2). Just like foreign policy and national security, energy policy and especially ES have been jealously guarded national policy remits where MS have been reluctant to transfer competence to the EU (Langsdorf, 2011:2; Andoura et al., 2010:25-26). Notwithstanding intense EU lobbying vis-a-vis MS at every energy crisis since the first oil crisis in 1973 (cf. Andoura, 2010:18-21; cf. Langsdorf, 2011:5), energy policy has largely remained a national affair (Nilsson, 2011:1509). This means, that the EU was never given the competence to formulate, propose and let alone implement a comprehensive European policy on energy.

The two avenues for exercising influence in energy policy that are being used by the EU today are the internal energy market (IEM), and environmental and especially climate policy (Tosun & Solorio, 2011:4; cf. Nilsson, 2011:1509). The idea of establishing an internal energy market is a logical continuation of the competences conferred upon the EU in the SEA and the Maastricht treaties to establish and regulate the internal market (ibid). Starting in 1996 several energy market packages were proposed and passed in order to also establish an internal market in energy and to guarantee free and fair competition (Wettestad et al., 2012:74). The Commission today oversees and regulates the internal energy market in tight cooperation with national regulators. Issues such as guaranteed access to grids and transparent price competition, but also such things as, ownership unbundling of generation, distribution and retail assets in the electricity and gas markets and establishing interconnections between national grids and networks are all part of the IEM policy (Nilsson, 2011:1520). The declared purpose behind establishing the IEM is to achieve affordability for European energy consumers (Andoura et al., 2010:27). The belief is that open and transparent energy markets are more efficient and that a larger IEM will allow companies to realize economies of scale, both of which should put downward pressure on energy prices (ibid:28).

The other route for the EU to shape energy policy is through the "backdoor" of environmental policy integration (EPI) (Tosun & Solorio, 2011:5). Compared to energy, the EU enjoys a somewhat stronger position and more political will by the MS for legislating environmental policies. The political will was especially strong in the run-up to the COP15 in Copenhagen in 2009, when the EU wanted to act as an international leader on climate policy and wanted to have policies in place, which demonstrated its credible commitment to climate policy goals (Oberthür & Roche, 2008:39). EPI is a principle, which basically states that policies that have an impact on environmental goals must be adapted to reflect environmental concerns[23] (Persson, 2004:13). The principle of EPI is even explicitly mentioned in Art. 11 TFEU (EU, 2010). Because energy policy has quite a large impact on climate policy goals the EU has used the justification of EPI to significantly influence energy policy through the implementation of climate policy measures (Tosun & Solorio, 2011:5). Some of the goals[24] of the CEP are realized through policies directly targeting the energy sector, such as the "renewables directive" (2009/28/EC) the "EUETS directive" (2009/29/EC) or the "Energy Efficiency Directive" (2012/27/EU). Whether one calls it climate policy that affects the energy sector, or whether one calls it energy policy in pursuit of climate goals is more a question of branding and keeping MS happy than of content. According to the European Commission (2013h), at least two of the three targets of the CEP (the renewables target and the energy efficiency target) also promote energy security.

The introduction of Article 194 TFEU in the Lisbon treaty (EU, 2010) marks the first time, that an enabling provision on energy policy is part of the treaties (Filis & Leal-Arcas, 2013:1251). This provision however is no energy policy by itself, and it provides no tools for achieving any of the policy goals stated in it (ibid). While its effective use as a legal basis is hampered by a derogation from the ordinary legislative procedure, which effectively allows a national veto (Art. 194§2 TFEU, EU, 2010), it may yet serve as a legal basis for future legislation on energy policy if the MS can agree. In practice, energy policy today is only being comprehensively pursued (if at all) at the national level (Andoura et al, 2010:69).

2.2.2 Attempts of a European Energy Security Policy

Because of the EU's high import dependence in energy and perhaps also against the backdrop of the gas supply disruptions suffered in January 2006 in connection with the Russia - Ukraine gas dispute[25], the EU published a Green Paper in March 2006 in which it calls for a "common response" to the ES challenges of the EU (European Commission, 2006). Perhaps unsurprising to the reader, and despite a positive reception of the green paper, little concrete action has followed in terms of policies or legal instruments (Andoura et al., 2010:49). Instead of concrete action there has been a ritual of diagnosing the problem of energy security of supply in the EU, and of formulating high-flying policy solutions for solving it (ibid). Already in the year 2000, the European Commission published a detailed green paper entitled "Towards a European Strategy for the Security of Energy Supply" (European Commission, 2000). Strategies have since been formulated but the EU has still not acted on them. The latest communications by the Commission on the future energy policy of the EU, the Energy 2020 Strategy (European Commission, 2010) and the Energy Roadmap 2050 (European Commission,

[23] i.e. become "integrated" with environmental policy
[24] The famous 20-20-20 targets (see section 2.1.1)
[25] For a comprehensive assessment of the Russia-Ukraine gas dispute see Pirani et al., (2009)

2011) have continued to embrace new ambitions for EU energy policy at the same time as no concrete legislative progress is made.

The case of Germany pursuing the Nordstream pipeline in a bilateral agreement with Russia, despite objections by Brussels, Sweden, Poland, and the three Baltic states, which were circumvented by the pipeline, illustrates the impotence of the EU in foreign affairs and energy security policy (Filis & Leal-Arcas, 2013:1270).

In the realm of ES, three legal instruments concerning the stability of the oil, gas and electricity supply respectively, are some of the few concrete measures the EU has actually implemented[26]. These measures mandate emergency stocks in oil and gas and common operational procedures for their use, as well as grid interconnections and emergency procedures in case of electricity blackouts (Andoura et al., 2010:52-54). In light of the fragmented and incomplete state of European energy policy and short of a dedicated European energy security policy or exclusive European competence in this area, the best the EU can do is to "reverse-engineer" EPI into some sort of "energy policy integration" to ensure that the existing policies like the EUETS support the stated policy goal of ES (cf. Gault, 2007:2).

[26] Council Directive 2009/119/EC for oil, EU Regulation No. 994/2010 for gas, Directive 2005/89/EC for electricity.

3 Theory

This chapter introduces the theoretical framework of institutional interaction in order to conceptualize how one policy such as the EUETS may influence another policy (or policy goal) such as EES. The second part of this chapter introduces the concept of energy security and puts forward an operational definition of ES with the help of which an ES analysis of the five abatement options can then be performed in the analysis chapter.

3.1 Institutional Interaction

3.1.1 Institutional Interaction and Related Concepts

When asking how the EUETS affects EES, analytically we are dealing with the question of how one policy impacts, influences or interacts with another policy. This sort of question has been examined by many different authors in a range of different policy contexts, and theorizing around this question has taken place under several different labels. In search for a suitable analytical framework I reviewed the theories of *Environmental Policy Integration* (EPI, cf. Underdal, 1980; Persson, 2004)*, Policy Coherence for Development* (PCD, cf. Den Hertog & Stross, 2011:4), *Climate Mainstreaming/Climate Policy Integration* (CPI, cf. Mickwitz et al., 2009; Dupont&Oberthür, 2012) and *Policy Coherence* (cf. Den Hertog & Stross, 2011; Nilsson et al., 2012). The problem with all of these approaches is that they are too prescriptive and insufficiently analytical. They either prescribe ways for achieving integration/coherence/consistency etc. or they present rather incomplete approaches for analyzing the degree of coherence/integration/consistency etc. between two policies. In this study, however I would like to start one step prior and analyze *how* policies interact rather than presupposing an interaction and already analyzing the degree of it.

After a very extensive literature search I found a theoretical model that provides the tools for analyzing the preceding step, and fittingly enough it is called *Institutional Interaction*. It is by far the most complete as well as detailed analytical concept of its kind that I came across in my search for theory. It is also the approach that fits best with the purpose of this study, because it provides a useful framework for analyzing and understanding interactions directly i.e. the causal mechanism that connects cause and effect, rather than only the outcome of interactions. I thought it to be problematic at first to rely exclusively on the model provided by Oberthür&Gehring (2006), a single source, for conceptualizing the interaction between the EUETS and EES. However the completeness of the model, its analytical fit with the research question and the fact that few alternatives exist in the under-theorized field of interaction, as well as its limited claims to explain the empirical world make a strong argument for relying on it anyway despite a certain risk of bias coming from the dependence on a single source.

3.1.2 Defining Institutional Interaction

Because they found existing analytical concepts insufficient, Oberthür & Gehring developed *Institutional Interaction* as an analytical framework for their empirical study analyzing the interactions of eleven international environmental regimes and EU policies (2006:9, 22). The main tenets of the conceptual framework are the concepts of institutional interaction, of institutions and of causal mechanisms.

Institutional interaction refers to a causal relationship between two institutions, where the source institution exerts influence on the target institution, thus affecting the institutional development and effectiveness (performance) of the target institution (Breitmeier, 2000:45; Oberthür&Gehring, 2006:26). But how are institutions defined in this context? Oberthür & Gehring (2006:5) employ Keohane's (1989:3) definition of institutions as "persistent and connected sets of rules and practices that prescribe behavioral roles, constrain activities and shape expectations". Of the institutions defined in such a way, I only focus on deliberately established (negotiated) institutions because they are employed instrumentally to bring about societal change, e.g. achieve specific policy objectives (Oberthür&Gehring, 2006:23). Institutions may also emerge as a result of spontaneous uncoordinated behavior, examples would be the institutions of state sovereignty and international customary law, but such institutions are not created and developed intentionally as governance instruments and therefore not at the focus of our study of institutional interaction (ibid). Negotiated institutions generally consist of two parts 1. substantive rules and obligations that indicate socially desirable behavior, and 2. particular decision-making processes from which norms and behavioral guidelines emerge (ibid:23). Governance institutions are designed to influence the behavior of relevant actors in order to achieve specific policy goals (ibid:39). Sectoral EU policies as expressed in regulations and directives are considered functional equivalents of negotiated institutions, as they usually include norms and guidelines which prescribe desirable behavior to specific actors, and EU policies usually also have their own decision-making processes, both in the form of specific comitology procedures for implementation and one of several legislative procedures for their formulation and amendment (ibid:25). The supranational bodies of the EU, which are also often and confusingly called "European institutions" are not considered institutions according to our definition, because they do not represent a system of norms, rules and decision-making processes that was deliberately created to govern a given policy area, but rather they are seen as general organizational arrangements (ibid:24).

Recalling the definition of institutional interaction from the previous paragraph, establishing a specific case of institutional interaction requires three steps (ibid:26):

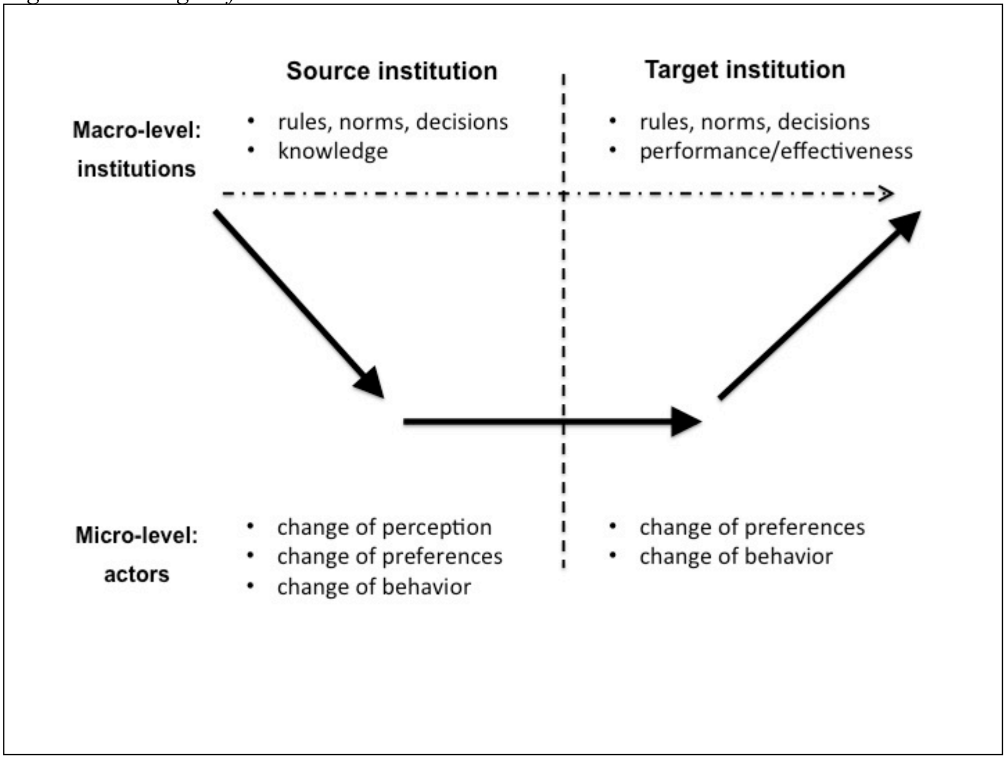
1. Identifying the source institution and the relevant rules/decisions from which influence originates.
2. Identifying the target institution and the relevant parts of the target institution or issue areas governed by it that are subject to the influence of the source institution.
3. Identifying a unidirectional causal pathway connecting the two institutions, which crucially must include an observable effect on the target institution.

The effect on the target is *constitutive* of a case of interaction, without a discernible effect on the target institution there is no interaction. Interaction here is defined as one single unidirectional relationship that runs from source institution to target institution (ibid:27). It does *not* mean that influence runs back and forth between institutions (ibid). When institutional interaction occurs, it is often the case that there are multiple cause-effect relationships that run in multiple directions between two or more institutions, and sometimes even in different temporal sequences. In such a situation, each one of the cause-effect relationships should be seen as a separate case of interaction, and analyzed in isolation. The key to analyzing institutional interaction is thus the *disaggregation* of a complex situation into an appropriate number of cases of interaction (ibid:29-30). The causal link itself is a product of the nature of the relationship between the source and the target institution. Disaggregation does not prevent one from recombining cases of institutional interaction into a more complex picture, once each causal relationship has been analyzed individually (ibid:31).

3.1.3 Causal Mechanisms of Institutional Interaction

Oberthür&Gehring (2006:32) describe a causal mechanism as "[...]a set of statements that are logically connected and provide a plausible account of how a given cause creates an observed effect" (ibid:32). It can be thought of as an abstract model or a hypothesis of the actual causal pathway that a case of institutional interaction follows that must be theoretically coherent, but cannot be empirically right or wrong (ibid:33). Before causal mechanisms can be described, the basics of the model need to be introduced: micro and macro levels, actors, output, outcome and impact.

Figure 2. The logic of causal mechanisms



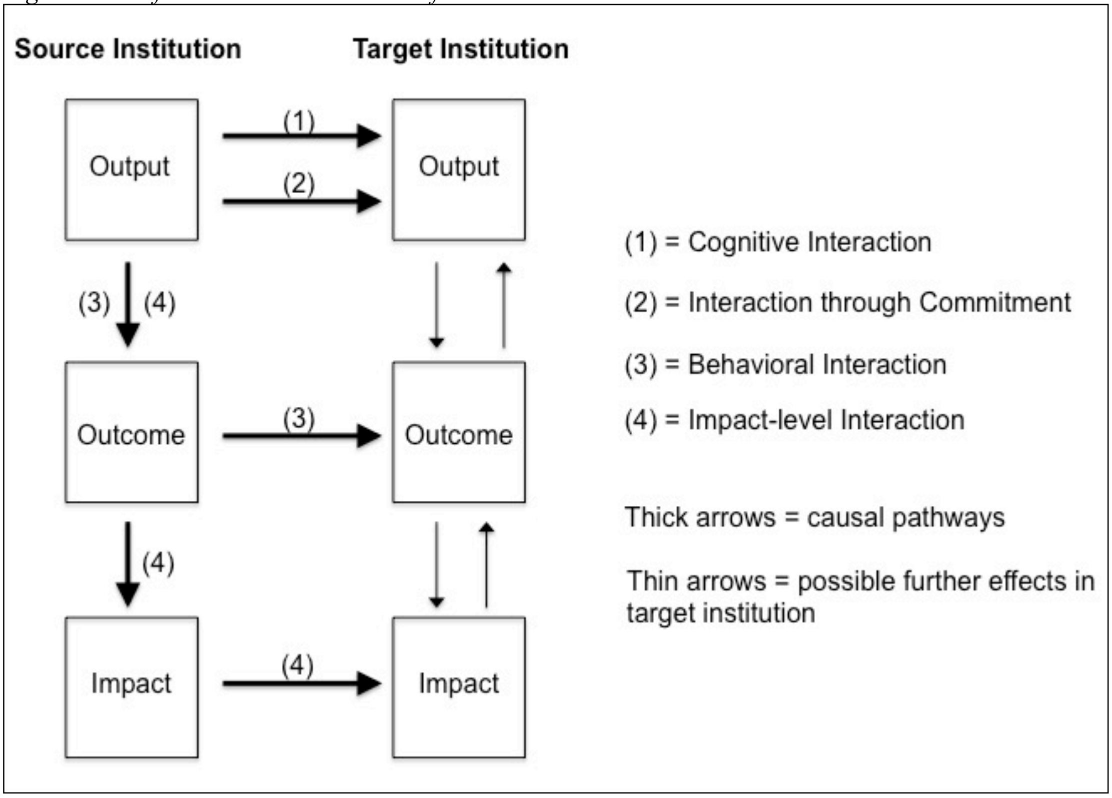
Source: Adapted from Oberthür & Gehring (2006:33)

In agreement with authors such as Buzan, Jones and Little (1993), Alexander and Giesen (1987) and others, Oberthür and Gehring (2006:32) also distinguish between a micro and a macro level as the basis for describing the agent-structure relationship. They see relevant institutions, both source and target as located on the macro level, where rules, norms, decisions and knowledge reside. In institutional interaction actors on the micro level are the crucial link between cause and effect, between source institution and target institution. Institutions such as an EU policy cannot directly act, they merely produce output, i.e. knowledge or norms that may prescribe, proscribe or permit behavior. Actors are the targets of the output of institutions. In the case of the EUETS the actors at whom the output is directed are mainly the operators of large GHG-emitting installations, however there is a wide range of possible types of actors. The actual behavior change in actors that the output of an institution achieves is called outcome. This outcome may or may not result in an impact on the ultimate target of governance or on a target institution (ibid:34). In a practical example, the output may be seen as the ban of drinking when driving. While the outcome of the ban is the actual behavioral change of drivers not drinking when they drive, the impact on the ultimate target of governance is a decrease in road accidents and fatalities.

Since the effect on the target institution is constitutive of institutional interaction (ibid:27) it forms the starting point of any inquiry into the causal mechanism that ties together source and target institution (ibid:35). Oberthür&Gehring (2006:32) developed four distinct causal mechanisms:

- cognitive interaction,
- interaction through commitment
- behavioral interaction
- impact-level interaction

Figure 3. The four causal mechanisms of institutional interaction



Source: Adapted from Oberthür & Gehring (2006:43)

These mechanisms describe four different ways in which source institutions may affect target institutions.

Cognitive interaction stipulates that the decision-making process of a target institution will be influenced if information, knowledge or ideas produced within the source institution modify the perception of relevant decision-makers in the target institution. The changed perception of the decision-makers may in turn alter the decisions of target institutions and thus their output (Oberthür&Gehring,

2006:35). Cognitive interaction is purely based on persuasion and may thus be be resisted by the target institution.

Interaction through commitment is thought to take place when actors entered commitments at the source institution, which entail certain obligations and subsequently change their preferences vis-a-vis the target institution. It is based on the desire of actors to avoid mutually incompatible obligations. In this particular form of interaction temporal sequence is important as already existing commitments usually are the ones that influence preferences of actors vis-a-vis other institutions and subsequent commitments.

The third distinct causal mechanism is *behavioral interaction*. In this particular model of interaction the target institution is affected at the outcome level by the behavior of actors that has been caused by the source institution. At the start the source institution's output influences the behavior of actors within the source institution's domain (outcome). These behavioral changes impact the outcome of the target institution thus influencing its performance and effectiveness. The effect of behavioral interaction on the target institution is produced by the uncoordinated behavior of actors and does not depend on any decision in the target institution. It thus marks a large degree of unilateral influence of the source institution over the target institution. (Oberthür&Gehring, 2006:39-41)

The fourth causal mechanism developed by the two authors is *impact-level interaction.* In this case the governance objective of the source institution is functionally linked to the governance objective of the target institution, so that the achievement of the objective of the source institution itself influences the achievement of the objective of the target institution. In practice, impact-level interaction is difficult to observe because it is often diffuse, involves long causal chains and requires expert scientific knowledge of both issue areas in question. (Oberthür&Gehring, 2006:39-41, 44)

3.1.4 Categorizing Impacts on the Target Institution

It is important and interesting to assess what kind of effects a given case of interaction has on the ultimate governance objectives (i.e. policy goals) of the target institution because it answers the question whether a given case of institutional interaction is desirable from the point of view of the target institution (e.g. EES). The consequences of institutional interaction may be assessed in terms of their effect on the policy direction of the target institution (Oberthür&Gehring, 2006:45). Policy direction indicates "the direction of collectively desired change or the objective of maintaining a desired status quo against a collectively undesired change" (Gehring, 1994, 443-449). Oberthür & Gehring (2006:46) categorize the effects of institutional interaction on the policy direction of the target institution as beneficial, adverse or neutral. In this study the effects on the target institution are called positive effect, indeterminate effect and trade-off.

In the policy analysis literature positive effects of one policy on another are often called synergies (cf. Oberthür&Gehring, 2006:46; Adelle et al., 2009:22-25, Kruyt et al., 2009:2173; etc.). In my opinion, using the word synergy to denote a positive effect is an inaccurate and misleading use of the term because synergy is defined as: "*The interaction or cooperation of two or more organizations, substances, or other agents to produce a combined effect greater than the sum of their separate effects*" (Oxford Advanced Learner's Dictionary, 2005). According to Oberthür&Gehring's own definition (2006:46), the main question is whether the effect is beneficial, adverse or neutral. Whether it is larger than the sum of its parts or not is secondary at best and does not form the center of analytical focus.

In order to denote the situation that arises when institutional interaction has adverse consequences on the target institution I employ the term trade-off. In their book on public sector reform, Pollitt&Bouckaert (2011:184), define a trade-off as a situation where "... lessening one problem inevitably diminishes some other wished-for quality or increases a different problem".

The third term employed by the authors is "indeterminate effect" (Oberthür&Gehring, 2006:46) which I find fitting for the situation where the nature of the effect on the target institution is either neutral or cannot be determined.

Figure 4. Classification of impacts on target institution

Nature of effect on target institution	Resulting situation
beneficial	positive effect
adverse	trade-off
neutral	indeterminate effect

3.1.5 The EUETS and European Energy Security as a Case of Institutional Interaction

Let's recall from the previous section that identifying institutional interaction requires three steps: identifying the source institution and the specific rules from which influence originates, identifying the target institution and the parts of it that are subject to influence from the source institution and identifying a unidirectional causal pathway between the two institutions where a causal mechanism is at work. The first step is to identify the institutions: the EUETS as the source institution and EES as the target institution. The EUETS is a based on the EUETS directive (2009/29/EC) and as such it has already been defined as the functional equivalent of an institution by Oberthür & Gehring (cf. 2006:25). The specific rule of the source institution (the EUETS) where influence is assumed to originate, has already been identified in the previous chapter (Section 2.1.3) as the abatement options that operators have in order to reduce their GHG emissions, which are thought to influence EES. EES has been included in the Lisbon treaty as a policy goal for European energy policy (Art. 194§1 TFEU, EU, 2010). As such it also represents norms of behavior that are directed at actors, in this case the member states of the EU and its supranational bodies. Even though Art. 194 TFEU does not put a *specific* legal obligation on MS or EU supranational bodies, the specification of ES goals can be seen as recommendations or statements of intent, and since Oberthür&Gehring have not specified the degree of bindingness that norms, rules and guidelines must have, I interpret them to be sufficient for Art.194§1 TFEU to fulfill the first half of the definition of institution put forward by Oberthür&Gehring (2006:23)[27].

The second half of the definition of institution makes reference to a decision-making process, which enables the institution to formulate and amend its norms (Oberthür&Gehring, 2006:23). In the case of EU legal instruments such as directives and regulations, the decision-making procedures of comitology and the legislative procedure that precedes their creation are considered by Oberthür&Gehring (2006:24-25) as equivalents of the kind of decision-making procedures present in institutions. At the time of writing (2014), there exists no specific EU directive or regulation for achieving EES, and there is therefore no comitology procedure for implementation either. But Art.194 TFEU does have an enabling provision in §2, which specifies the ordinary legislative procedure for adopting specific legal instruments for energy policy or ES policy. I interpret the enabling provision in Art. 194§2 TFEU to be the kind of decision-making process that defines institutions. It allows the target institution of EES to amend and formulate its rules and guidelines. EES thus also fulfills the second criterion for being an institution. The specific aspect of the target institution that is assumed to be susceptible to influence from the source institution, is the policy goal of energy security of supply that is stated in Art. 194§1 TFEU (EU, 2010). It is one of the ultimate targets of governance[28] of the target institution, and if it is influenced, the performance of the target institution (i.e. the achievement of some of its policy goals) is impacted. The definition of security of supply is discussed in the second half of this chapter.

Having identified both the EUETS and EES as institutions, and their aspects where influence originates and impacts respectively, the unidirectional causal pathway that is assumed to exist between these institution only becomes clear once the analysis of each abatement option in chapter five is performed. Once the details of each causal link are described, they can be categorized into one of the four causal mechanisms, and the nature of the impact on the target institution can be assessed.

[27] "Negotiated institutions generally consist of ... 1.) substantive rules and obligations that indicate socially desirable behavior..."

[28] using the terminology of Oberthür&Gehring, 2006:34

3.2 Energy Security

Energy Security is a fuzzy concept, and there is no consensus among researchers and policy analysts about its exact definition or its operationalization (Valentine in Sovacool, 2010:56; Checchi et al., 2009:3). It is both a policy goal and an analytical category. The analytical category, defining what ES actually means, comes first. Relative to the chosen definition, one can then assess the current ES-situation as well as formulate a desired state of affairs as a policy goal (cf. Seebregts et al., 2007:19). In this study, the potential impact on ES of the different abatement options available under the EUETS is analyzed relative to the concept of security of supply as employed by the EU. Because I analyze the impact of the EUETS on the institution of European Energy Security as embodied by Art.194§1 TFEU and several policy papers (cf - section 3.1.5), I choose to also use the same definition of ES as the EU.

Starting with the green paper "A European strategy for the sustainable, competitive and secure energy" in the year 2006, the European Commission has defined three separate goals for its energy policy: sustainability, competitiveness and security of supply (European Commission, 2006:17). In the energy policy research field many other approaches to defining ES exist and are used, but the European Commission has kept its analytical categories the same over the years. It has employed them in the 2007 Communication "An Energy Policy for Europe" (European Commission, 2007:3-4), in the 2008 Communication "Second Strategic Energy Review" (European Commission, 2008:4), in the 2010 Communication "Energy 2020. A Strategy for Competitive, Sustainable and Secure Energy" (European Commission, 2010:2) as well as in the latest policy paper, the 2011 Communication "Energy Roadmap 2050" (European Commission, 2011:5). Unfortunately, I could not find a more detailed definition of security of supply provided by the EU itself. Even though the policy goal of security of supply features somewhat ubiquitous in official EU documents on EU energy policy, if there are specifications at all, they usually consist of concrete measures or initiatives that increase ES rather than a definition of the concept. It will therefore be necessary to lean on other sources for the definition of security of supply. Competitiveness refers to the question of whether the available energy supplies can be consumed at a price, which "will not adversely affect the performance of the economy" (APERC, 2007:6). Sustainability of energy supplies refers to the notion that the energy that is supplied also needs to live up to certain minimum social and environmental requirements (Kruyt et al., 2009:2171).

In this study I use the term ES synonymously with security of supply (cf. Kruyt et al, 2009:2167) and deliberately exclude competitiveness and sustainability from its definition. Also the EU treats security of supply, competitiveness and sustainability as separate concepts, both in Art.194§1TFEU and in the above-mentioned publications. While I do acknowledge that both competitiveness and sustainability are important goals of energy policy, I do not consider them part of the definition of ES for practical reasons of analytical clarity. To include sustainability would make it difficult or impossible to identify trade-offs between the EUETS goals and ES, because sustainability is part of both. Climate mitigation can be viewed as being part of environmental sustainability[29] and if sustainability is also part of ES, every time an abatement option under the EUETS fulfills its own policy goal of climate mitigation, it would automatically also partly contribute to ES. It would thus always count as a partly positive influence on ES, even when it is in contradiction to the other goals of ES. To avoid this sort of double-counting the sustainability criterion is not included in the ES definition for this study (cf. Winzer, 2012:41). Similarly, competitiveness is an economic criterion and the EUETS is a policy instrument that uses economic (dis-)incentives by putting a price on GHG emissions. Since the EUETS works via the price mechanism, it is bound to have multiple economic impacts on competitiveness because it essentially makes energy from fossil fuels more expensive. The impacts on competitiveness certainly do merit study, and indeed, contrary to the ES- aspects of the EUETS, the potential economic impacts of the EUETS were evaluated by the EU in a policy impact assessment of the proposed climate and energy package in the year 2008 (European Commission, 2008b). I concur with Winzer (2012:41) in the assertion that competitiveness should be considered an issue of economic efficiency rather than of ES. The inclusion of a "competitiveness" sub-concept in ES would risk rendering ES meaningless because every economic impact of the EUETS, of which there are bound to be many, would also count as an impact on ES.

3.2.1 Defining ES: Availability, Accessibility and Reliability

Security of supply, or the continuous and uninterrupted availability of energy (Groenenberg & Wetzelaer, 2006:6), can be summarized to mainly depend on three sub-concepts: availability, accessibility and reliability of energy supplies (cf. Sovacool & Mukherjee, 2011:5347-5352; APERC, 2007:5-6). These sub-concepts of ES focus on the requirements that are considered necessary to achieve a secure energy system. Choosing these three sub-concepts of security of supply comes after multiple iterations through many scientific articles concerning the definition of ES. As has been mentioned in the beginning of the section, there is no consensus definition of ES. But it is the impression of this author that the concepts behind the labels of "availability, accessibility and reliability" are counted as constitutive of ES by most authors, even if they sometimes carry different labels like "sovereignty, robustness and resilience" (cf. Cherp & Jewell, 2011:206).

Availability refers to the physical existence of sufficient energy sources to satisfy the demand of a given economy or society (Sovacool & Mukherjee, 2011:5345; Checchi et al., 2009:1; APERC, 2007:5). The *availability* aspect of

[29] i.e. climate mitigation is part of keeping the ecosystem of the earth intact, for the original definition of sustainability please see WCED (1987) *a.k.a.* the "Brundtland Report"

security of supply has to do with the scarcity of primary fuels (Kruyt et al, 2009:2167). It deals with such questions as; "Is there enough oil in the ground to satisfy present and future demand?", or "Would it be physically possible to fuel the cars of the world with biofuels?", but also "Could we produce all the electricity we need from renewable energy sources (RES)?". *Availability* is the most basic constraint on ES. If the energy resource is not there, it cannot be consumed. The more energy that is available of a given energy source the better it is considered for energy security.

Accessibility refers to geopolitical circumstances and international relations determining or influencing the access to energy resources. The basic issue in accessibility is resource concentration, i.e. the uneven global distribution of energy resources, plus the fact that energy is often not consumed and produced in the same place (Kruyt et al, 2009:2167; Adelle et al, 2009:21; IEA, 2007:36). The fact that the EU consumes much more energy than it produces, and that it has to import the difference[30], makes it import dependent for 52,7% of its total energy consumption, 62,4% of its natural gas consumption, and 84,3% of its oil consumption (Eurostat, 2012:29). In an EU context, accessibility is about whether the EU is able to acquire access to energy resources that lie outside its territory. Energy exporters as well as transit countries may be able to extract political concessions and economic rents if they are in a dominant supplier position (Gupta, 2008:1196). The EU and even more so Japan are both vulnerable and exposed to accessibility problems (IEA, 2012:76; European Commission, 2008:3). Phenomena such as the "energy weapon", energy embargoes or so-called "pipeline politics" become relevant in the context of accessibility (Yergin, 2006:75; Smith-Stegen, 2011:6506). In terms of accessibility it is generally considered better for ES if the energy is source is physically close to the place where it is consumed rather than far away, better if it exists in many rather than just a few supplier countries (diversification), it is better if the energy source is located in a friendly rather than in an unfriendly country, and better if the energy source is located in the own territory of a state rather than in the territory of another state.

Reliability refers to the absence of, or safety from sudden supply disruptions, whether they are caused by natural disasters, technical failure or human interference (terrorism, etc.) (Winzer, 2012:37). It deals with questions such as the reliability and vulnerability of energy infrastructures to extreme events (Seebregts et al., 2007:17-21), but also the degree of substitutability of energy sources and suppliers and buffer capacity, so as to better withstand a sudden disruption of any single source of energy (Chester, 2010:891; Yergin, 2006:76). Reliability is concerned with sudden, i.e. short-term impacts (Chester, 2010:891).

When assessing ES time plays an important role (cf. Chevalier, 2006:3; Chester, 2011:891). The timing, duration and sequence of events can make a difference for their impact on ES. In each of the three analytical categories presented above, the temporal dimension of ES-impacts plays a role. Insufficient

[30] mostly in the form of fossil fuels (Eurostat, 2012:29)

availability of an energy source for example assumes very different degrees of urgency and importance depending on whether it concerns the short term or the long term, as the long-term depletion of an energy source can be prepared for. Reliability is by definition concerned with short-term impacts. But what does long-term or short-term actually mean in the context of energy security? Both are relative measures of time. Jansen & Seebregts (2010:1654) determine the long-term to be 10 years or more and refer to investment cycles and the time for policies to take effect in the energy sector. Since the potential impacts of the abatement categories of the EUETS are on ES and therefore also on the energy sector, it appears useful to employ a similar duration of 7 - 10 years as Jansen&Seebregts (ibid) to define the long term.

4 Method

4.1 Methodological Choices

The research paradigm of this study is scientific realism. Scientific realism posits that knowledge can be gained by observing generative mechanisms in action (Pawson&Tilley, 1997:57). A generative mechanism explains an outcome by taking into account inputs, causal mechanisms and the context in which they occur (ibid:58). Insights about how generative mechanisms work are gained through a mixture of theorizing and realist experimentation often in the form of case studies (ibid:57). Scientific realism differs from positivism in the sense that the "control-group logic" of positivism in the social sciences only looks at inputs and outcomes to confirm or reject pre-set hypotheses (black-box problem), whereas scientific realism investigates the actual mechanisms that bind them together (ibid:30). Scientific realism also differs from social constructivism in the sense that unlike constructivism it assumes that knowledge can be neutral despite the risk of bias (ibid:21). Scientific realism goes hand in hand with the ontological position of objectivism, i.e. that reality has an existence that is independent of the mind and of social actors (Bryman, 2012:32), but that it is imperfectly apprehensible by the researcher and that facts can therefore be more or less perfect reflections of reality ("modified objectivism", Healy&Perry, 2000:120). The scientific realism paradigm is wide-spread in the policy analysis and evaluation research disciplines as well as in marketing and management research, however discussions of research paradigm are relatively rare in the policy research literature (ibid; Pawson&Tilley, 1997:55-56). Scientific realism dovetails well with the approach taken in this study, because contrary to positivism it also allows for causality to be identified in single case studies (Maxwell, 2004:5). The theoretical framework of institutional interaction employed in this study, which aims to identify and describe various causal pathways (Oberthür&Gehring, 2006:27), and hypothesizes causal mechanisms (ibid:32) rests on similar ideas about generating knowledge. In the context of this study, hypothesizing causal pathways means finding out which aspects or policy outputs of the EUETS may have an impact on ES, and then investigating exactly how this impact would come about, which is akin to describing a generative mechanism.

This study uses theory largely in a deductive, theory-consuming fashion. The theoretical framework of institutional interaction is used to help explain what kind of relationship exists between the EUETS and EES, and the concept of ES is chosen as framework for assessing the impacts of the EUETS on ES. However, while deductive approaches often aim to test or even develop theory (Bryman, 2012:24-25), this study mainly consumes theory (cf. Esaiasson et al., 2007:42-44) in order to explain the outcome of the case, which is deemed important in its own right.

4.2 Research Design: Single Case Study

A research design "provides a framework for the collection and analysis of data" (Bryman, 2008:31). The research design of this thesis is a single case study design, utilizing qualitative data from a literature review (cf. Weimer&Vining, 2005:310). Bryman (2008:51) states that: "a case study entails the detailed and intensive analysis of a single case". George & Bennett (2005:17) define a case as "an instance of a class of events". A case is the unit of analysis the research question prescribes (Bryman, 2008:54). It can be anything from a place, like a city, or a country, to a time period or a specific historical event, to an organization or a specific policy context (George & Bennett, 2005:17). Case studies are well-suited to explore the existence of causal relationships, and to give a rich description of their nature (ibid:29).

The case under examination in this study is the case of institutional interaction between EUETS and EES. It is an exploratory case study because little is known about the potential causal mechanism between the two policies. A "detailed and intensive analysis" of the causal mechanism that binds together the EUETS and EES is thus performed in order to answer the research question. It is a qualitative case study because the information necessary to answer the research question is mainly available in the form of qualitative data. Qualitative in this study does not denote the whole package[31] of methodological choices often assumed to accompany qualitative research, but simply points out the fact that the data on which this study is based is text rather than numbers, and that it is analyzed using a literature review method rather than a quantitative method of data analysis.

4.3 Data Collection Method: Literature Review

The data collection method chosen for this study is a literature review method. The purpose of employing the literature review method in this study is not to give a general overview of the literature, but to elicit from the large number of existing reports, papers and other publications on ES and on climate mitigation, cues about how the EUETS may influence EES (cf. "thematic analysis", Bryman, 2008:554).

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[31] The "qualitative research package" is often said to consist of an inductive or grounded theory approach to theory, an interpretivist epistemological position, and a constructionist ontological position (cf. Bryman, 2008:366, 593). This combination is common but not binding (ibid:23, 593)

In line with guidelines for literature reviews (Hart, 1998) and taking cues from literature reviews of the ES and climate mitigation subject areas performed by other authors (e.g. King&Gulledge, 2013; Zhang&Wei, 2010; Månsson et al., 2012), I defined what kind of sources to include. The sources for the literature review are peer-reviewed academic journals, grey literature as well as research anthologies and university textbooks. Grey literature denotes reports, working papers, policy summaries, analyses etc. from a range of organizations such as international organizations, government agencies, policy research consultancies as well as think tanks and industry associations (cf. King&Gulledge, 2014:3-4). What is important to consider in grey literature is that it is often government funded or funded by specific interest groups, and that there is therefore often a specific research agenda (ibid, Weimer&Vining, 2005:313-314). In both ES and climate mitigation the high quality and the relatively neutral and quantitative nature of many publications in the grey category are noteworthy.

Doing my literature review I proceeded in two rounds. The first round was performed to gain a good understanding of the EUETS and of EES respectively, and to identify the policy outputs of the EUETS that may have an impact on ES as conceptualized in this study (cf. “constructing parameters”, Hart, 1998:31). Guiding questions (cf. Hart, 1998:60; “thematic analysis”, Bowen, 2009:32) for the first search round were: “how does the EUETS work, and what is its policy context?”, “how is ES conceptualized?”, “what is the policy situation regarding European energy security?” and “what aspects or outputs of the EUETS may influence EES?”. The search for literature was performed using the academic databases of Lund University (lubsearch) and a list of keywords related to the topic area (see appendix). With the guiding questions in mind, search results were skimmed, sorted, read, sorted, and finally organized using a system of searchable tags and annotations (cf. Bowen 2009:32; Hart, 1998:54). The keyword search was supplemented by snowball sampling, basically looking up the sources given in the articles and reports reviewed when they were given in support of statements or information which appeared important in relation to the guiding questions of the literature search (cf. “purposive sampling”, “theoretical sampling”, Bryman, 2008:458-462). The results of the first search round are summarized in chapter two (background), which I consider crucial for understanding the analysis, and they are also contained in the second half of the theory chapter conceptualizing ES for this study.

Once the five abatement categories were identified, a second search round was performed. This time however, in order to answer the second part of the research question, the guiding questions were “how does each abatement category work?” and “what effects does each abatement category have on availability, accessibility and reliability of energy supplies respectively?”. Apart from the changed guiding question the literature review was performed in the same way. In the absence of probabilistic sampling techniques, the tools of concept corroboration and category saturation were used as aids in order to decide what sources and how many sources to select as answers to the guiding questions. Saturation refers to the notion that the categories relating to the guiding question are filled with data from the reviewed literature until “[…]the point of diminishing returns, when nothing new is added” (Bowen, 2008:140; cf. Bryman, 2008:416, 462). Concept corroboration refers to corroborating findings across different data sets and thus reducing the risk of bias and error (Bowen, 2009:28; Bryman, 2008:379). An example for corroboration from this study would be the claim that natural gas is traded regionally rather than globally. This claim could be found in two different sources, published by different organizations and with different purposes (cf. CRS, 2013:1; Checchi et al., 2009:15), and is also reflected in the IEA gas information statistics, which lists the countries buying and selling natural gas from each other, the amounts, and whether gas is traded by pipeline or by LNG (IEA, 2013a:II38, II54). Especially when a piece of information determines which way the assessment will go, it is important that it is corroborated.

The findings of the literature review are summarized in a condensed form, in a narrative that describes a potential "causal pathway" (cf. Oberthür&Gehring, 2006:33) of how each climate mitigation option (potentially) influences availability, accessibility and reliability of energy supply.

4.4 Quality Criteria

Choosing to employ a literature review as data collection method for a case study in combination with the methodological stance I take in order to answer the research question of this study, brings up some methodological challenges. I address these challenges through a discussion of the research criteria for case studies formulated by Yin (1994:33): construct validity, internal validity, external validity and reliability. A separate set of quality criteria for research under the realist paradigm has been developed by Healy&Perry (2000), but even one of the creators himself, Perry (2001:318), concedes that the most widely-used and understood quality criteria for qualitative case studies are the ones formulated by Yin (1994:33).

4.4.1 Construct Validity

Construct validity is concerned with the link between concepts and indicators, with the question whether the operationalization of a concept into one or several indicators is actually "measuring" what the concept is looking for (Yin, 1994:34; Bryman, 2008:152). Case studies in particular have been the target of criticism relating to subjective judgments about data selection (Yin, 1994:34), and this study being a case study is equally susceptible to that criticism. One remedy that Essaiasson et al. (2007:24-25) suggest is to allow for intersubjectivity through transparent reasoning. This means making explicit the decisions taken in relation to concepts and research, and providing arguments for them (ibid). In this study, the research question "*How does the EUETS potentially affect European energy security*" is made more concrete step by step. First, the outcome of the EUETS that is most likely to affect ES is identified: abatement categories (Section 2.1.3). Next a theory about how a policy outcome like abatement may possibly influence (affect) other policies is provided in the form of the institutional interaction framework (Section 3.1). Next, a concrete conceptualization of ES is provided (Section 3.2) including the three sub-concepts of availability, accessibility and reliability, against which an assessment of ES impacts can be performed. At each point a clear argument is presented for each choice, as e.g. the argument in support of the chosen conceptualization of ES excluding economic and sustainability aspects (Section 3.2). Rather than going the last step of developing qualitative and quantitative indicators for ES, the concept of ES has been operationalized so far that the evidence from the literature review can be assessed directly vis-a-vis the conceptualizations of the sub-concepts of ES.

It has to be stated clearly that this study does not seek to establish "the one" influence of the EUETS on ES, but that it aims to present several *plausible* causal pathways of how the EUETS may *potentially* affect EES. This is not to exclude the possibility that other ways may also exist. The reasons for this modesty are the early stage and lack of agreement in theorizing ES, the complexity of the subject area and the absence of direct evidence on abatement in the EUETS sector. Given these modest aims and the correspondingly low risk of over-generalization, the risk of subjective data selection should weigh less heavily.

4.4.2 Internal Validity

The criterion of *internal validity* refers to the question whether the observed effect in the dependent variable is really caused by the independent variable, or whether something else had caused it (Bryman, 2008:32). This criterion is not applicable to this study, as we do not set out to *prove* the causal relationship between abatement options and EES impacts. Rather set out to explore a *plausible* causal pathway (cf. Oberthür&Gehring, 2006:32-33) of how the EUETS may *potentially* affect EES.

4.4.3 External validity

External validity is concerned with the question of whether the results of a study are generalizable beyond the immediate case that has been studied (Yin, 1994:36; Bryman, 2008:33). Most tests of external validity boil down to the sampling technique that has been used, because they implicitly or explicitly refer to statistical generalization (Yin, 1994:36). Because case studies, especially single case studies like this one, do not employ probabilistic sampling, statistical generalization of results is also not applicable (ibid). The limits to generalization implied by the case study design are not in contradiction to the purpose of this study, which considers the interaction the EUETS and EES to be sufficiently important to merit investigation in its own right, even if results are not generalizable.

4.4.4 Reliability

Reliability is concerned with the question of whether the results of a study are stable and repeatable, i.e. whether the same results would be produced if the exact same study was conducted again (Bryman, 2008:31; Yin, 1994:36). In the context of qualitative case studies it is recommended to carefully document procedures (i.e. audit trail) for improving reliability[32] so that studies can be repeated or audited (ibid). In this study, documentation is provided in the form of a list of search terms used for the literature search, the academic literature search engine (lubsearch) that was used is specified, and importantly sources for factual claims made in the ES-analysis are provided. It is thus possible for an auditor/evaluator of this study to verify each source, and to check whether the same conclusion would have been drawn from the evidence contained in the source.

4.4.5 Challenges

It has to be stated, that the choice of literature review as data collection method entails challenges of both low reliability and low internal validity. However these challenges are balanced by the specific advantages of a literature review, which make it possible to conduct this study at all. The literature review of existing studies makes it possible to assess what would otherwise be an unmanageable amount of data, in an economic and condensed fashion. Assessing the ES impacts of climate mitigation options directly, rather than through a literature review as for example through a comprehensive indicator approach, would produce enormous amounts of data and complexity and requires considerable expertise in economics and other disciplines, which I do not possess (cf. Kruyt et al. 2009; von Hippel et al., 2011; Sovacool&Mukherjee, 2011). In addition to the prohibitive requirements in expertise, time and resources for such a study, it would still be prone to bias, as there is no agreement on which indicators should be used to measure which sub-concept of ES and how to weigh them (cf. Winzer, 2012:42-43). Reliability as well as internal validity would probably be superior to a literature review. Given the practical limitations, as well as the modest purpose of this study to describe only a *potential* causal pathway of how the EUETS influences EES, the literature review - case study format is still a good choice. Despite its shortcomings in reliability, internal validity and risk of bias, literature review is one of the most commonly used data collection methods in the policy analysis domain (Weimer&Vining, 2005:310), both for finding facts and theories for solving policy problems.

[32] which again is very similar to the qualitative research criterion of dependability

5 Analysis

In this chapter the nature of the interaction between the EUETS (the source institution) and EES (the target institution) is analyzed. For each climate mitigation option identified in section 2.1.3, a short description of how it contributes to climate mitigation is given. Then a detailed analysis is performed of how each respective mitigation option potentially impacts availability, accessibility and reliability of the energy supply, and the causal pathway of institutional interaction thus described. Third, the impacts on ES are categorized as “positive effect”, “trade-off” and “indeterminate effect”. Categorizing the nature of the impact in such a way, allows us to answer the research question for each abatement option, how it potentially influences EES. Lastly, having the description of how each mitigation option potentially impacts ES, the kind of causal mechanism (i.e. cognitive, commitment, behavioral and impact) present in each of them is assessed. For better overview, the results of the ES-analysis are presented in a table at the beginning for each respective abatement option.

5.1 Switch to Gas

5.1.1 Climate Mitigation Impact

Switching to gas as energy source constitutes a climate mitigation option because the combustion of gas emits less CO_2 than other fossil fuel sources. Switching from the current world-average coal-fired power plant to a modern natural gas combined cycle power (NGCC) plant, reduces emissions per kWh by 52% over the life-cycle of both energy sources (Burnham et al. 2012:624). The reason for the lower emissions is the lower carbon content of gas compared to coal and the higher efficiency of combined-cycle gas power plants (ibid). The GHG emissions occurring during the exploitation of unconventional gas or shale gas have not yet been reliably quantified, but preliminary results point towards 1,8% - 2,4% higher GHG emissions than conventional gas (cf. Stephenson et al., 2011:10762). Switching from coal to gas can thus reduce GHG emissions by a maximum of 52%, which is compatible with the 21% emission reduction target of the EUETS until the year 2020 (European Commission, 2013b), but insufficient for reaching the 80% - 95% emission reduction target that the EU has set itself for the year 2050 (European Commission, 2011:3). Gas can thus be seen as a bridge fuel that facilitates emissions reductions to a certain point but is not an option for achieving the long-term climate policy goals.

The gaseous state of natural gas necessitates pipelines or other gas-tight means of transport and storage, which represent large infrastructure investments relative to the price of the product (Stern, 2002:9-10). Gas-fired power plants on the other hand are relatively inexpensive and quick to build compared to other power plants (cf. IAEA, 2013:41-42; Boyle et al., 2003:383). Natural gas is widely used as energy source in the industrial and power sectors (under the EUETS), and for residential heating (Boyle et al., 2003:254-256). Only if the distance between the source and the consumer is too large and gas pipelines not economical or technically feasible, the even more expensive method of gas liquefaction[33] is used. LNG is then transported on large gas tanker ships to ports with dedicated LNG terminals where gas is de-liquefied again and pumped through local pipelines to the point of consumption.

5.1.2 Impact on ES

Figure 5. Potential impact of a switch to gas on EES.

Availability	Accessibility	Reliability
indeterminate effect	trade-off	indeterminate

With the exception of LNG, which constitutes a small share of the world gas market but a major energy source for Japan and the Republic of Korea (cf. IEA, 2013a:II51, 57), and in contrast to oil, gas is not a globally traded commodity. Instead it has regional buyers and sellers, and prices on different regional gas markets differ (CRS, 2013:1; Checchi et al., 2009:15). When looking at availability of natural gas for Europe, one has to keep in mind this regional limitation. Supplies of natural gas are plentiful in North America thanks to the so-called shale gas boom, but transport to Europe increases the price (IEA, 2013:117). The reference scenario developed by the European Commission indicates that despite an overall reduction in energy demand, natural gas demand will remain relatively stable in absolute terms until 2050 (European Commission, 2014:35). There are sufficient NG resources to satisfy future European demand (IEA, 2013:107), but they are located in producer regions outside Europe, mainly the Persian Gulf region, Russia, Central Asia and to a smaller extent North Africa (IEA, 2013a:II66-II67). Natural gas supply is estimated to be sufficient to satisfy future European demand, but only if the relatively uncertain reserves of unconventional gas are considered, do natural gas reserves come anywhere near the abundance of coal reserves in terms of energy content (IPCC, 2014b:16). I

[33] LNG - liquefied natural gas

therefore judge a switch (presumably from coal to gas) to have an indeterminate effect on availability.

Accessibility of natural gas is an important issue for the EU. In 2012 the EU imported 65,2% of its total natural gas consumption (Eurostat, 2014) from outside the union and 83,4% of these imports came from only four suppliers: Russia (31,9%), Norway (29,4%), Algeria (13,8%) and Qatar (8,7%, via LNG) (Eurostat, 2014). Domestic gas production in the EU has been in decline for several years (CRS, 2013:1; Checchi et al., 2009:15). Despite some alleviation of the decline trend through the addition of domestic unconventional gas (shale) (IEA, 2013:118), the decline of domestic gas production will continue (European Commission, 2014:49), so that progressively larger shares of gas demand will have to be satisfied through gas imports (ibid:50). Despite its large production rate Norway is estimated to hold only about 1% of world gas reserves in its gas fields, whereas Russia's reserves are estimated at ca. 31%, Iran 17% and Qatar 13% (IEA, 2013a:II66). No pipeline infrastructure exists to transport gas from Iran or Qatar to Europe, and the security situation in Iraq and Syria as well as the current economic sanctions imposed by the EU on Iran make gas supply contracts with Iran and pipeline construction in the area unlikely. The Caspian Basin countries, Azerbaijan, Turkmenistan, Kazakhstan and Uzbekistan are estimated to hold 7% or more of world gas resources, but so far their only export route to the EU is via the Russian/Soviet pipeline system (CRS, 2013:18). All of the above-mentioned factors seem to underline the poor accessibility of natural gas in the EU. There is resource concentration in a small number of countries all outside EU territory. The ability to diversify gas suppliers and supply routes is further hampered by the lack of independent pipeline infrastructure to the Central Asian countries and to the Persian Gulf countries, and by the high cost of LNG. Overall the choice of gas as a climate mitigation option has an adverse impact on the accessibility of energy, and there is therefore a trade-off between abating emissions by switching to gas and accessibility of energy.

Concerning reliability, i.e. the risk of sudden supply disruptions, the EU is vulnerable to producer country risk. If Russia decides to use its position as a dominant supplier to the EU in order to extract political or other concessions by threatening to withhold gas supplies, something that Russia has never done, not even during the Cold War (Checchi et al., 2009:19), Europe would have some difficulty finding substitutes for its Russian gas imports in the short run. It is true that there is interdependence between exporting and importing countries, and that exporting countries have large infrastructure costs for gas fields and pipelines which require steady long-term revenue flows to amortize over many years (ibid:17). In the short term however interdependence is asymmetric, especially during the winter, importing countries are much more dependent on gas deliveries than exporting countries on payment (Smith-Stegen, 2011:6511). The reasons for supply disruptions do not have to be political, they may be as trivial as insufficient maintenance of some pipeline pumping station in Siberia, which may have the same result (Checchi et al., 2009:18). Some EU countries are almost 100% import dependent on natural gas and have almost no storage capacity, which leaves them exposed to supply disruptions (cf. Eurostat, 2012:35; IEA, 2011:7). The current crisis in Ukraine highlights the transit country risk, which stems from the fact that most pipeline capacity from Russia to the EU crosses through third countries like Ukraine or Belarus, which may interrupt gas flows to extract concessions from both sides (Checchi et al., 2009:20). The Nordstream and South Stream gas pipelines built by Russia have the express purpose to reduce transit country risk by bypassing them via an undersea route (Boussena&Locatelli, 2013:184). The risk of sudden stops in gas delivery can be alleviated through storage capacity[34], diversification of supplies (e.g. LNG terminals) and it is also alleviated by the fact that natural gas can be relatively easily substituted through oil or coal in electricity production, and that especially the price of oil acts as upper bound for the gas price (Tönjes&DeJong, 2007:17). In electricity production, combined cycle gas turbine (CCGT) power plants have an important role of covering peak demand as they can be cold-started within a few hours and warm-started within ca. 30 minutes (Boyle et al., 2003:382). CCGT are also relatively cheap and fast to build compared to other power plants, and are therefore favored by risk-averse private investors (ibid:383, 502). So while they make the electricity grid more reliable, they are themselves exposed to reliability risks of sudden supply disruptions. I thus assess a switch to natural gas to have an indeterminate effect on reliability, because the positives and the negatives cancel each other out.

5.2 Switch to RES

5.2.1 Climate Mitigation Impact

The term renewable energy sources (RES) is an umbrella term for a range of different technologies which harness energy from sources which are naturally replenished at a rate which equals or exceeds their rate of use (IPCC, 2011:178). Many RES produce electricity but some produce heat or other forms of useful power. The main RES's with some degree of worldwide diffusion are: hydro power, wind energy, geothermal energy, ocean energy, direct solar energy and bioenergy (ibid:174). Even these different sources still contain sub-categories like off-shore and on-shore for wind energy, pumped-storage or running-water for hydro, photovoltaic or concentrated solar thermal for solar etc. It is impossible to treat RES at this level of detail in this study, which is why the ES analysis of RES is going to focus mostly on the characteristics that are shared by the different RES technologies.

RES-E[35] are considered a climate mitigation option because their average life-cycle GHG emissions in gram CO_2/unit of energy are orders of magnitude smaller

[34] Austria for example maintains underground gas storage reservoirs sufficient to store more than half a year's gas consumption for the country (IEA, 2011:7).
[35] Renewable energy sources for electricity production.

than those of fossil fuels (Weisser, 2007:1554; cf. IPCC, 2014b:35). Mitigation takes place when low-GHG RES replace high-GHG fossil fuels. The direct emissions of RES in electricity production are often zero or close to zero (IPCC, 2011:174) and the emissions over the lifecycle usually stem from the production of the energy generating machinery like turbines and from maintenance (Weisser, 2007:1552). Some RES-E technologies (e.g. hydroelectric dams) have significant environmental impacts other than on climate change (IPCC, 2011:714). For Res-E to be feasible, there needs to be RE potential in the geographic area of their deployment (ibid:820). Because of several kinds of barriers, economic, technical and political, the deployment of RES cannot be sufficiently stimulated by a carbon price alone, and governments therefore devised different kinds of RE support policies (ibid:871-872). Under the EUETS, operators do not have to surrender any allowances for energy from RES (cf. 2009/29/EC, Annex 1), which serves as the incentive to switch to RES.

5.2.2 Impact on ES

Figure 6. Potential impact of switch to RES on EES.

Availability	Accessibility	Reliability
positive effect	positive effect	short-term trade-off, long-term positive effect

When it comes to availability, several studies indicate that RES-E potential both worldwide and in Europe exceeds current energy demand by several times (IPCC, 2011:183). A study by the Stockholm Environment Institute (SEI) estimates that in order to satisfy not just electricity demand, but the entire energy demand of Europe through renewables by the year 2050, only 11% of the total technical renewable energy potential of the continent needs to be used (Heaps et al., 2009:33). However the potential for individual RE technologies varies widely as can be seen by the difference between hydropower where approximately 64% of available potential are already used (DLR, 2009:116) and on-shore wind power, where only 0,5% of available potential are used (EEA, 2009:32) The scenarios developed by the SEI show that it would be technically feasible to switch the entire electricity production of Europe to renewables as mitigation option, even excluding nuclear energy and the deployment of CCS-fitted fossil-fuel power plants (Heaps et al., 2009:9). In the case of a full switch to RES-E, up to 85% of present electricity supply would have to be progressively replaced by renewables (ibid:36). This would imply that in the period of 2020 - 2030, 5000 large wind turbines per year would have to be built (ibid:32). Because of the large domestic potential of RES it is clear that a switch to renewables that would tap into this potential, would improve availability of energy supplies.

Because the domestic RES-E potential of the EU is rather large compared to its energy demand (IPCC, 2011:183) at the same time as the EU has to import much of its fossil fuel needs from outside the union (Eurostat, 2012:29), many ES assessments of a switch from fossil fuels to RES conclude that it has a positive impact on accessibility (cf. IPCC, 2011:724; Johansson, 2011:9-10; Checchi et al., 2009:32). Large-scale centralized RES-E production like the desertec project[36], may yet introduce new energy dependence on unstable regions, and large-scale off-shore wind farms in the North Sea may still be far away from the places where energy is actually consumed. However, since the potential for domestic RES-E is estimated to be so large that there is no need for RES-E imports, switching from fossil fuels to RES-E is considered to improve accessibility because it replaces (fossil fuel) energy sources that are concentrated outside the territory of the EU with (renewable) energy sources inside the territory of the EU.

Reliability. The technologies for generating renewable electricity already exist, and are at different stages of maturity (IPPC, 2011:182-183). However the energy system needs to be adapted in order to be able to accommodate them (Johansson, 2011:13). In the short run, there is a risk that adding more RES-E to the grid without adapting the electricity system accordingly undermines reliability because of the intermittent nature of many RES-E. The problem of intermittency of some RES[37] can be solved by a combination of measures including reinforcing transmission lines, adding pumped hydro capacity to enable load balancing[38], and introducing demand management (Heaps et al., 2009:34-36). The problem is that such measures take time to implement. Building new transmission lines in Europe often takes much longer than building new RES-E power plants because of lengthy approval processes (IPCC, 2011:636; IPCC, 2014b:30). Building pumped hydro power stations is complicated by the many requirements mandated by the EU water framework directive, by long construction times and by finding financing for the large up-front investment requirements (IEA, 2012c:23, 42). Equally so, demand management requires the roll-out of so-called “smart-grid” technology, as well as giving consumers, especially industrial ones, time to adapt to the fact that their electricity consumption follows electricity production rather than the other way around (Heaps et al., 2009:34-36). In order to avoid reduced reliability of the electricity grid, expansion of RES-E generation capacity has to be carefully synchronized with the adaptation of the power system (Johansson, 2011:13). The fact that under a liberalized electricity market generation, transmission and distribution of electricity have to be strictly separate, does not necessarily make the task of coordinating the adaptation of the energy system any easier (Checchi et al., 2009:36).

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[36] A gigantic concentrated solar power (CSP) project in the Sahara desert, sending electricity to Europe via a high voltage transmission line (Lilliestam&Ellenbeck, 2011:3380).

[37] the fact that some renewables do not continuously produce electricity because the wind does not always blow and the sun does not always shine.

[38] in simple terms, load balancing means storing surplus electricity and releasing it again when there is a shortage (Boyle et al., 2003:379-380)

Once the transition to a RES-E based electricity system is successful however, the resulting kind of electricity system brings several benefits for reliability. Increased transmission capacity and demand management techniques not only allow the energy system to cope with sudden fluctuations in energy supply due to normal occurrences like weather conditions, but also if they are caused by things like strikes, terrorist attacks, sabotage etc. (IPCC, 2011:639). Especially pumped hydro power stations are currently the only power plants that can provide massive additional capacity within a few minutes in order to cover for unexpected peak electricity demand or shortfalls from intermittent sources (Boyle et al., 2003:379). The deployment of small-scale renewables opens up the possibility of decentralized generation, meaning that electricity is consumed much closer to where it is produced and thus avoiding conversion and transmission losses (IPCC, 2011:181). It can thus be said, that RES-E expansion has some possible disadvantages for reliability in the short run, while it is a clear reliability improvement in the long run when the necessary infrastructure is in place.

5.3 Switch to Nuclear

5.3.1 Climate Mitigation Impact

Nuclear energy produces electricity in nuclear reactors, utilizing a process called nuclear fission to release vast amounts of energy in controlled chain reactions from the core of uranium^{235} atoms. In this process no GHG are released which is why a switch to nuclear from GHG-intense energy sources qualifies as climate mitigation (NEA, 2009:1; IPCC, 2014b:23). Nuclear energy, just as RES, does however emit some GHG at different points in its lifecycle, e.g. uranium mining, uranium enrichment, construction of nuclear plant, nuclear waste disposal etc. (Weisser, 2007:1552). Even when the life cycle emissions of nuclear are taken into account, the resulting emissions in gCO_2/kWh are orders of magnitude smaller than combustion of fossil fuels (ibid:1554; NEA, 2009:2). The obstacles to the use of nuclear energy are manifold, but they are mostly related to economic, sustainability and security issues rather than ES or climate concerns. There are serious security concerns about nuclear proliferation and catastrophic nuclear accidents, the question of permanent nuclear waste disposal remains unresolved, and the construction of nuclear infrastructure requires large up-front investments that only amortize after decades of successful operation (IPCC, 2014b:25; NEA, 2009a:9-11). Only thirty countries operate nuclear reactors and only a handful master the complete nuclear fuel cycle (IPCC, 2014b:23). The fact that the EUETS counts nuclear energy as GHG-free[39] increases the profitability of

[39] Nuclear power plants are not covered by the EUETS directive (cf. 2009/29/EC, Annex 1)

existing nuclear power plants (NPPs), but due to the existence of market barriers it is currently not enough of an incentive to motivate the construction of new NPPs (NEA, 2011:8-10).

5.3.2 Impact on ES

Figure 7. Potential impact of switch to nuclear on EES.

Availability	Accessibility	Reliability
long-term positive effect, short-term indeterminate	positive effect	positive effect

Uranium is the fuel source of the 440 civilian nuclear power plants worldwide, requiring 63 875 tU to produce 375 GWe or 11% of the world's electricity (IAEA and NEA, 2011:12) and 28% of the EU's electricity in 2010 (Eurostat, 2012:38). Of the annual uranium requirements, 85% is satisfied from uranium mine production, while the rest comes from spent fuel reprocessing as well as from downblending of highly enriched military uranium from the dismantling of nuclear warheads (IAEA and NEA, 2011:13). At current world demand, uranium supplies from the 7,1 MtU identified resources[40] are calculated to last more than 130 years (IPCC, 2014b:18). Another 7,6 MtU are reported as "undiscovered resources", which are a little less certain and would add another 130 years of supply (IAEA and NEA, 2011:29). Forecasts of future growth in nuclear energy production range from the "low case" of 540 GWe to the "high case" of 746 GWe of installed capacity by the year 2035, compared to today's 375 GWe (ibid:94). The limiting factor to availability of nuclear energy however is not primarily the amount of recoverable uranium in the ground but the rate of technological progress and the choice nuclear fuel cycle, which has important consequences for safety, cost and efficiency (IPCC, 2014b:24). Most countries with civilian nuclear power based on light water reactors use so-called "once-through" nuclear fuel cycles, where 95% of the uranium is left unused in spent fuel rods which go into nuclear waste disposal (IAEA, 2013:51). So-called fast breeder reactors in combination with spent fuel reprocessing could extract 50 - 70 times more energy from existing uranium resources than current nuclear fuel cycles (ibid). Fast breeder reactors are not yet commercially available, but both France and the Russian Federation run industrial scale breeder reactors for research and development purposes (ibid:52). The cost of nuclear fuel, including processing and enrichment represents only a small part (10%-20%) of the total cost of

[40] Identified resources consist of the rar category (reasonably assured resources) and the inferred resources category (cf. IAEA and NEA, 2011:9). Both categories are relatively certain as opposed to the "undiscovered resources" category which is prognosticated and speculative (ibid).

producing electricity from nuclear power (NEA, 2009a:14). The larger challenge to availability of nuclear energy are its "front-loading" cost structure and the rather long lead times for construction of new nuclear capacity. The timely investment in new nuclear power plants, investments in uranium mining and in adequate fuel cycle infrastructure (IAEA, 2013:52) thus become critical for the availability of nuclear energy. NPPs are expensive to build but relatively cheap to operate (ibid:36). The lead-times for nuclear power projects are often ten years from conception until commissioning of a plant, and the up-front investment requirements are about 60% of the life-cycle cost of an NPP (IAEA, 2013:39, 54). Because of the long time periods, the large up-front investment requirements and the related uncertainty, sufficient investment capital for the construction of nuclear infrastructure is usually only found with the direct or indirect support of states (NEA, 2009a:49). In the context of the EU liberalized electricity markets, this means that exemptions from state-aid rules have to be applied for at the European Commission (European Commission, 2013i). All of the above implies that availability of nuclear power is not constrained in the long run, but that it may be difficult to expand nuclear within a short timeframe.

With regards to accessibility, data of the Euratom Supply Agency for 2012 show that the EU is import dependent for ca. 94% or of its natural uranium purchases (Euratom, 2014). This import dependence however is mitigated by a number of factors. First, yellowcake or U_3O_8, the form of uranium after milling but before enrichment, that is sold on the world market, has a high energy density in comparison with fossil fuels, low radioactivity, and is easy to transport and to store in 200-litre metal drums (Swan, 2009:49; Boyle et al., 2003:422). Consuming countries can thus easily accumulate buffer reserves of uranium equaling several years of consumption at low cost in order to protect themselves from supply disruptions. This is the case in the EU, where at the end of 2012, EU utilities had inventories of 52 362 t of natural uranium, amounting to more than two years of consumption (Euratom, 2014). Second, uranium mines are spread over the world and with the exception of Kazakhstan much of current uranium mining and identified uranium resources are located in stable and friendly countries like Australia, Canada and the US, and supply is thus diversified (NEA, 2010:8; IAEA and NEA, 2011:18, 59). Third, for all practical purposes, nuclear power can be regarded as a domestic energy source, as about 90% of its inputs in terms of value are sourced domestically (NEA, 2010:7). This means that even if temporary supply shortages and associated price swings should occur on the world market for uranium, the impact on electricity prices is relatively limited compared to the situation for fossil fuels (Checchi et al., 2009:28). The modest share of nuclear fuel cost (10% - 20%, NEA, 2009a:14) in the total cost of nuclear energy production, is the reason why price swings in uranium do not threaten the economic viability of nuclear power production. This compares favorably to coal where the share of fuel cost represents 35% - 45% of the total production cost of electricity and natural gas where fuel cost represents 73% - 77% of the total (ibid). The three above-mentioned factors: low cost storage of buffer reserves, diversified international supply and relative immunity of consumer countries to price swings in uranium, give nuclear energy a relatively good accessibility, despite the fact that the EU is import dependent for its uranium supplies.

Nuclear energy is generally considered a reliable source of base-load electricity. For the electricity grid to work and avoid blackouts, supply and demand of electricity must always be in balance (Boyle et al., 2003:377-379). Because demand fluctuates widely throughout the day, electricity from power plants has to be constantly added or removed from the grid. The proportion of demand that is always there, and that always has to be satisfied, is called base load (ibid). Producing base load electricity means in simplified terms to let a power plant run at full capacity all the time. NPPs are ideal for base load generation because of their low proportion of variable and high proportion of fixed cost (ibid). Nuclear power is generally considered reliable, however, in the unlikely event of a nuclear accident, because of the inherently hazardous nature of nuclear technology, the resulting downtimes of an NPP are potentially very long, and the damage caused by nuclear accidents potentially catastrophic and irreversible (Checchi et al., 2009:29). In the time period from 1952 - 2009, 99 nuclear accidents have occurred causing US$ 20.5bn in damages (Sovacool, 2010a:379). Given the above description, nuclear energy can be categorized as reliable in terms of energy security, however highlighting the possibility of black-swan type negative events.

5.4 Use of CCS

5.4.1 Climate Mitigation Impact

Carbon dioxide capture and storage (CCS) is a process where CO_2 is removed (captured) after combustion or other chemical processes, and is subsequently stored in underground geological reservoirs (IEA, 2009:9). Since it removes CO_2, a GHG, which would have otherwise been released into the atmosphere, it qualifies as a climate mitigation option (IPCC, 2014b:25). The technology of CCS is still under development, and is still very expensive and energy-intensive (IEA, 2012b:338-339). Cost is especially relevant under the EUETS, where an abatement option will only be pursued if it has lower cost than the other available abatement options (cf. Perman, 2011:219). The reason why I choose to analyze this option anyway is because great hopes are pinned on it, as CCS is included as a crucial component in most future climate mitigation scenarios (IEA, 2012b:340), but also because it is expected to become commercially viable before 2030 when the EUETS is still expected to operate (IEA, 2009:27). So far it is only possible to commercially capture CO_2 streams of high purity (IEA, 2009:9). It is still prohibitively expensive to capture the sort of impure CO_2 streams occurring in fossil fuel power plants (ibid), which are by far the largest source of CO_2 emissions under the EUETS (EEA, 2013:21). Geological storage reservoirs would have to be continuously monitored as accidental release could suffocate humans and other breathing organisms in the area of the leak as well as dangerously increase atmospheric CO_2 levels (IPCC, 2014b:24). At the moment CCS technology is able to capture about 90% of the direct CO_2 emissions in the combustion of coal and gas (Koorneef, 2008:9-10; IPCC, 2014b:34) and to reduce emissions over the life-cycle of a coal power plant by ca. 78% (Koorneef, 2008:9). For natural gas power plants with CCS the reduction of CO_2 emissions over the life cycle is 64% - 73% compared to a plant without CCS (Singh et al., 2011:915). The difference in emissions reductions between gas and coal CCS is explained by the higher proportion of emissions in other parts of the life cycle for gas, especially fugitive gas during extraction and transport (ibid). The IEA estimates that CCS technologies with 85% CO_2 capture rates for all mature combustion processes will be commercially available around the year 2025 (IEA, 2009:27). CCS will make possible the prolonged use of some fossil fuels while reaching climate mitigation goals. If used in combination with biofuels (BECCS), it would even make possible the removal of CO_2 from the carbon cycle and thus be a chance to reduce atmospheric CO_2 concentration (IPCC, 2014b:27).

5.4.2 Impact on ES

Figure 8. Potential impact of CCS on EES.

Availability	Accessibility	Reliability
trade-off / positive effect	indeterminate effect	indeterminate effect

CCS is not an energy source but a measure that intervenes on the demand side of the energy equation. As such it has one direct and several potential indirect effects on ES. The direct effect is called the "energy penalty": Operating a CCS system consumes additional energy (IEA, 2009:26). The indirect effect on ES is fuel switching: CCS makes possible the continued use of fossil fuels in the presence of climate change mitigation. The indirect effect will be the ES impact of the fossil fuel source in question, which would not have been used in the absence of CCS[41]. It is beyond the scope of this study to analyze the indirect effects of CCS on ES that come about through fuel switching. The capture[42] of CO_2 increases the fuel use of installations by 12% - 27% (IPCC, 2005:119). Operators can only recuperate the cost of CCS, and will thus only deploy it, in the presence of a climate mitigation policy (IPCC, 2005:351). The IEA estimates that by 2025 the energy penalty for capture can be pushed to below 8% of additional fuel consumption in gas power plants (IEA, 2009:26). The energy penalty has a negative impact on availability of energy, as more energy is needed to produce the same amount of output, and existing supplies thus last shorter. CCS thus

[41] and in the presence of climate mitigation policies
[42] not counting the energy needed for transporting or storing CO_2

represents a trade-off for availability. However if we consider the carbon constraint as a fact of life the perspective changes because through CCS fossil energy sources become available which were previously excluded through a climate mitigation regime. In such a view, the deployment of CCS constitutes a new addition of energy sources to the resource base, and thus increases availability.

CCS has no direct impact on accessibility, as it is not an energy source. Its indirect effects on accessibility will depend on the choice of energy source that it enables in the presence of a climate mitigation policy. If for example through the deployment of CCS a switch to gas should occur, then the already problematic accessibility of natural gas (cf. section 5.1.2) would be exacerbated. It lies outside the possibilities of this study to make predictions about which energy mix will result from the deployment of CCS, and it is therefore impossible to tell here which indirect impacts CCS will have on accessibility.

At the moment CCS is still an experimental technology and as such it is normal that it is not yet reliable. Once CCS is mature enough for deployment, it is expected that it will not influence the reliability of any given energy source in any particular way (IEA, 2012b:346). Indirect effects on reliability would again result from the choice of fuel source enabled by CCS in the presence of climate mitigation policy, but cannot be analyzed in this study.

5.5 Improving Energy Efficiency

5.5.1 Climate Mitigation Impact

When a process is more energy efficient it delivers more output for the same energy input, or the same output for less energy input (IEA, 2014). Energy efficiency improvements constitute a climate mitigation option if they amount to a reduction in energy demand (IPCC, 2014c:84) and if the energy consumed involved GHG emissions. If the energy in question is produced free of GHG emissions (e.g. certain RES), demand reduction does not matter for climate mitigation, because no GHGs are emitted anyway. Energy demand reduction through efficiency improvements represent a climate mitigation option that is not tied to a specific fuel source, but which is applicable to all processes where fossil fuel-based energy is consumed[43] (IEA, 2012a:22-23). Several studies indicate that the potential for energy efficiency improvements in industry is as high as 25% (IPCC, 2014d:21). Through additional research and innovation another 20% of EE improvements may be added before approaching technological limits (ibid).

[43] and also applicable to processes where non-fossil energy is consumed, but then it is no longer climate mitigation.

5.5.2 Impact on ES

Figure 9. Potential impact of energy efficiency improvements on EES.

Availability	Accessibility	Reliability
positive effect	positive effect	positive effect

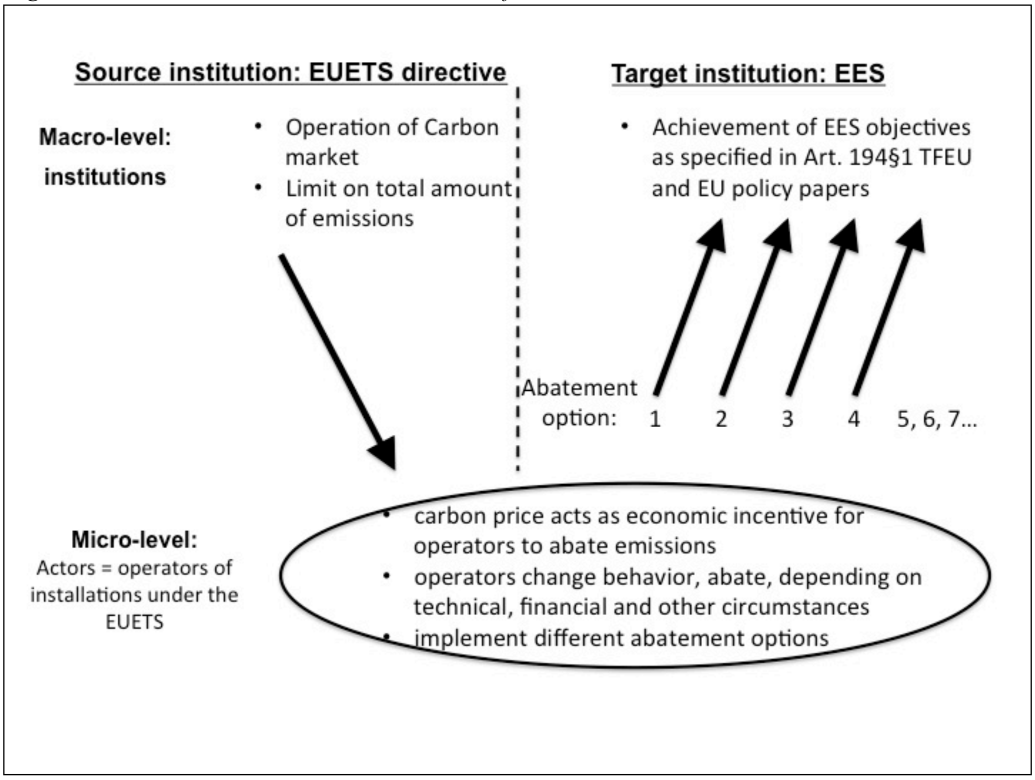
Energy efficiency (EE) improvements in the power and industrial sectors covered by the EUETS are expected to have several direct and indirect impacts on ES if they lead to demand reductions. Similar to CCS, EE improvements are also a measure that intervenes on the demand side of the energy equation, albeit in the opposite direction. While CCS carries an energy penalty, EE improvements are expected to lead to energy demand reduction (IEA, 2012a:16). Part of the efficiency savings are sometimes cancelled out by a rise in consumption: the rebound effect (ibid:25). Improvements in energy efficiency make the use of energy services cheaper, which encourages their increased use (Checchi et al., 2008:38). The rebound effect is estimated to cancel out anywhere between 10% and 50% of the efficiency improvement and in rare cases even more, meaning that any demand reduction will only be a percentage of the EE saving (UKERC, 2007:52). The rebound effect however can be counteracted by an energy tax or an emissions tax, in fact it is assumed that the existence of a carbon price under the EUETS will hamper any rebound effect (ibid:9).

Demand reductions have several positive impacts on ES. On an energy system level, less demand allows for larger safety margins of spare capacity, which reduces the vulnerability of the energy system to sudden and extreme events (Checchi et al., 2009:37). Gas and electricity infrastructure gain *increased reliability* if they operate with larger safety margins, both the transmission and the generation parts. Demand reduction also has a *positive effect on availability*, especially of finite energy sources (fossil fuels, nuclear), as each finite energy source lasts longer when it is consumed more slowly. It also has a *positive effect on accessibility*, as demand reduction can alleviate import dependence for energy sources (Furman et al., 2007:10, Selvakkumaran&Limmeechokchai, 2013:498). In the European context however demand reductions from EE improvements have historically been outweighed by the depletion rate of domestic fossil fuel resources, so that although overall demand had been reduced, a larger part of the remaining demand had to be satisfied through energy imports so that energy dependence actually increased (Checchi et al., 2009:38). However without the demand reductions, energy dependence would have been even higher.

5.6 Which Causal Mechanism?

Now that each abatement option and its impact on ES has been described in detail, it is possible to assess which causal mechanism is at work. Figure 10 depicts the causal pathways. Let's recall from chapter three that source institution, target institution and unidirectional causal pathway must be identified in order to establish a case of institutional interaction. Source and target institutions (EUETS and EES) have already been identified in section 3.1.5. Let's also recall that the causal pathway is defined by Oberthür&Gehring as "[...]a set of statements that

Figure 10. Behavioral interaction in the case of the EUETS.



Source: Own adaptation based on Oberthür & Gehring (2006:33)

are logically connected and provide a plausible account of how a given cause creates an observed effect.". Each abatement option that operators have should be viewed as a separate causal pathway and thus as a separate case of institutional interaction.

I argue that each case of institutional interaction between the two institutions should be categorized as behavioral interaction. Behavioral interaction posits that the behavior of actors induced by the source institution not only impacts the ultimate goal of governance of the source institution (i.e. climate mitigation), but also, inadvertently or not, influences the target institution, in our case EES. First the source institution's output, the carbon market, influences the operators to reduce their emissions collectively by the amount specified in the cap (European Commission, 2013c). The concrete steps that operators take to reduce emissions fall into one of the five abatement categories developed by the IPCC and used in this thesis. By taking concrete steps to reduce emissions, operators (i.e. actors) transform policy output (rules, guidelines, constraints etc.) into outcome. The summary in figure 11 shows that each of the analyzed abatement options also has some potential impact on at least some of the sub-concepts of EES (i.e. availability, accessibility and reliability). Even in those cases where the effect on ES is considered indeterminate, there is an effect on the target institution, only that it cannot be determined whether the effect is beneficial or detrimental for the ultimate target of governance of the target institution (EES).

In behavioral interaction, behavioral changes by actors (outcome) influence the performance and effectiveness of the target institution in some way (Oberthür&Gehring, 2006:40). The analyses of the different abatement categories in this chapter have shown that it is the behavior of the actors, their choice of how to abate emissions, that determines the resulting impact on EES. I therefore identify the causal mechanism present in each case of institutional interaction to be behavioral interaction, because it is what operators choose to do in order to meet the demands of the EUETS and abate that determines the impact on energy security.

Figure 11. Summary of abatement categories' potential impacts on EES.

Abatement Category	Availability	Accessibility	Reliability
Natural Gas	indeterminate	trade-off	indeterminate
RES	positive	positive	short-term trade-off, long-term positive
Nuclear	short-term indeterminate, long-term positive	positive	positive
CCS	trade-off/ positive	indeterminate	indeterminate
Efficiency	positive	positive	positive

6 Conclusion

This chapter summarizes the main results of this study, shows how the research question has been answered, and reflects upon the meaning and implications of the results. This study attempted to answer the following research question:

How does the EUETS potentially affect European energy security?

Sub-question: How do the different abatement options available to operators under the EUETS potentially influence European energy security?

Without repeating too much of the results already presented in the analysis chapter, it can be stated here that the EUETS *does* potentially affect EES, and that the effects depend on how operators choose to abate their emissions. One way of answering the research question would be to say that the EUETS affects EES through behavioral interaction. However, given the importance of the policy goals of increasing energy security in Europe and at the same time reducing GHG emissions in order to prevent catastrophic climate change, the analytical insight that it is indeed the behavior of the operators under the EUETS that determines what kind of impact it will have on EES, appears somewhat peripheral. Institutional interaction theory is a valuable aid for understanding how the influence of the EUETS on EES works, but it focuses attention on the question of how to change the behavior of the operators, when the more important question that is not sufficiently answered is what kind of behavior is necessary in order to increase energy security and reduce emissions at the same time.

This is why the sub-question needed to be answered. Knowing how the abatement options potentially affect EES, makes it possible to also consider ES-impacts when choosing how to abate. These results are summarized in figure 11.

It tells us that some of the abatement options analyzed clearly have a more positive impact on EES than others. But does knowing this fact change anything? From the institutional interaction analysis we also know that it is the behavior of the actors that creates the impact on the target institution. But will the actors change their behavior so as to increase EES simply because they are aware of the impact? It appears that the operators under the EUETS have the freedom to choose whatever abatement option they see fitting, but at the same time they are faced with an economic incentive structure through the carbon price that treats all abatement options equal. Shall we really expect operators to switch to a more EES-friendly alternative to reduce their emissions, when it is more expensive than pursuing a less EES-friendly alternative (e.g. gas)? Probably not if we also expect them to be rational economic actors. The polluter-pays-principle states that the polluter should pay for pollution prevention and for remedying the environmental degradation caused by it (Woerdman et al, 2008:572). Who should carry the cost of providing energy security to Europe? If we consider ES a positive externality, operators will always under-provide it unless policy corrects the market failure. Could such policy be reconciled with the EUETS? Can the EUETS be adapted to also promote ES at the same time as promoting climate mitigation? Or would a separate ES-policy be more effective in promoting it? This would be a good research question for a future study.

However before any corrective policy that supports EES can be introduced, we need to know how big the impact of the EUETS on EES is in reality. It is therefore paramount that governments start collecting and publishing data on the abatement behavior of operators. Once this data is published, a quantitative energy security analysis of actual abatement behavior of operators would need to be performed in order to determine if and how much corrective policy action is necessary to improve EES.

In a way this study was also a failure. As has been mentioned in the introduction and also in the method chapter, the reason why I conducted a single case study is because I consider the case a very important question for the future of Europe. I accepted not being able to generalize the findings beyond the context of that case, and I also accepted conducting a study with only a theory-consuming approach, even though theories concerning the interaction of policies and theories concerning ES are both in an early conceptual stage and in need of development. I accepted all of these shortcomings because I wanted to be able to say something important about the relationship between the EUETS and EES. The results of this study point to the fact that some climate mitigation options are problematic for EES while others are beneficial. The effect is thus mixed. However because I could not study the actual abatement behavior of operators, I was forced to add the caveat that it is not the actual effect of the EUETS on EES that is mixed, but only the potential effect. I have thus not developed theory, not generalized any findings beyond the context of the case, but also not said anything definitive about the case itself, only that there are *potential* contradictions between the EUETS and EES. For the gravity of these contradictions to be assessed, to know whether the EUETS needs to be adapted to also promote EES or not, further research is required.

While it may be a little bit troubling that in times of increased tensions with some of our biggest energy suppliers the EU does not have an energy security policy, and that it does not optimize the impact of the EUETS on ES, we can take comfort in the fact that options such as energy efficiency improvements, switch to RES or switch to nuclear exist, which allow the achievement of both ES and climate mitigation, and that they only wait to be implemented through effective policy.

7 Executive Summary

7.1 Introduction

Energy security and climate change are both important policy concerns in the European Union. Climate change is caused by the release of GHG into the atmosphere, which the EU seeks to reduce through its most important climate policy tool, the European Emissions Trading System (EUETS, European Commission, 2013e:2-4). It covers some 11 000 large industrial installations and power plants which produce about 45% of all European GHG emissions (ibid). Energy security has gradually become a concern for the EU, because of the high energy prices which persisted since the Iraq war in 2003, and the EU's high import dependence in energy (52,7% of all energy consumed, Eurostat, 2012:29), especially in oil (84,3% import dependence, Eurostat, 2012:33) and gas (62,4% import dependence, ibid:35). The link between the EUETS and energy security are fossil fuels. The combustion of fossil fuels stands for 77% of all anthropogenic GHG emissions (IPCC, 2007:103) and at the same time the EU is highly dependent on fossil fuel imports and is therefore vulnerable to price swings and supply disruptions. Since the EUETS forces the installations it covers to reduce GHG emissions, and most of these emissions come from fossil fuels which are problematic for European energy security we assume that the operation of the EUETS has an impact on EES. Policy experts and researchers disagree about the benefits of climate policies for energy security, however no dedicated study of the specific energy security impacts of the EUETS has to date been published. I therefore suggest the following research question and sub question:

How does the EUETS potentially affect European energy security?

How do the different abatement options available to operators under the EUETS potentially influence European energy security?

In order to answer the research question I conduct an exploratory qualitative case study, where the potential impacts of the EUETS on EES are treated as a case of institutional interaction. I investigate potential rather than actual effects, because data availability on actual abatement behavior by operators is poor. Abatement options are specifically included in the sub question, because abatement has been identified as the aspect of the EUETS from which influence on EES most likely originates.

7.2 Policy Context

The development, theory and functioning in practice of the EUETS as well as an overview of the ES situation and policy in place in the EU are important for understanding the analysis of potential institutional interaction between the two fields. The EUETS belongs to a category of policy instruments called "market-based instruments" that use price or some other economic variable to incentivize polluters/economic agents to abate pollution, and thus internalize an externality (Asafu-Adjaye, 2005:86; Saunier & Meganck, 2007:185). It is part of a broader package, the so-called "climate and energy package" that passed into law in 2009. The EUETS introduces a limit, a cap, on the maximum amount of GHG that can be emitted and issues permits for the amount of GHG that can be safely emitted, which operators must buy if their installations want to emit. The EUETS promises to reduce emissions at the lowest possible cost thanks to efficient allocation by market mechanisms. It also provides flexibility to individual installations, which can decide individually whether to reduce emissions (abate) or rather buy permits and emit. The problem with emissions abatement under the EUETS is that even though it is the desired outcome of the policy, no data is collected in a systematic fashion (Martin et al., 2012:43). Without such data we cannot know what the impact of these abatement activities is on EES. We therefore must turn to the IPCC, which developed categories of climate mitigation options into which efforts by operators in the energy and industrial sectors, i.e. the sectors covered by the EUETS, can be grouped. Rather than subjecting the actual abatement activities of EUETS operators to an ES analysis, I assess the ES impacts of the five abatement categories put forward by the IPCC. Operators must potentially choose some combination of them in order to reduce emissions, therefore it is a second-best alternative to analyze them.

Energy policy, of which energy security is generally considered a part, is best characterized by its absence from the EU policy realm for the longest period of the EU's existence. Article 194 TFEU in the Lisbon treaty (EU, 2010) marks the first time, that an enabling provision on energy policy is part of the treaties. In article 194 energy security is also stated as a policy goal. However the effective use of Art. 194 TFEU as a legal basis is hampered by a derogation from the ordinary legislative procedure, which effectively allows a national veto (Art. 194§2 TFEU, EU, 2010). Instead of a dedicated energy policy, the EU pursues energy policy goals through the backdoors of internal market policy and environment policy, in which it holds considerably more competences than in energy policy. The missing EU competence in this field explains the relatively modest progress in EU energy security initiatives, and this despite the fact that energy security is a pressing problem for the EU and that energy is an almost natural field for European integration because of its cross-border character.

7.3 Theory

The theoretical framework of institutional interaction (Oberthür & Gehring, 2006) is operationalized in order to conceptualize how one policy such as the EUETS may influence another policy (or policy goal) such as EES. Secondly, the concept of energy security is discussed and an operational definition of ES is proposed, with the help of which an ES analysis of the five abatement options can then be performed. Institutional interaction refers to a causal relationship between two institutions, where the source institution exerts influence on the target institution, thus affecting the institutional development and effectiveness (performance) of the target institution. It is defined as one single unidirectional relationship that runs from source institution to target institution. This relationship can take the form of cognitive interaction, interaction through commitment, behavioral interaction and impact-level interaction. The impact on the target institution is constitutive of institutional interaction, without it there is no case of interaction. It is assessed compared to the policy direction of the target institution, i.e. the direction of collectively desired change, and can be categorized into positive effect, indeterminate effect and trade-off.

Energy security is both a policy goal and an analytical category. Energy security in this thesis is defined to depend on the availability, accessibility and reliability of energy supplies. The concepts of economic efficiency (i.e. price security) and sustainability (i.e. environmental security), which are sometimes included in definitions of energy security are consciously excluded for reasons of analytical clarity and problems with double-counting. Availability refers to the amount of a given energy source that is available to a given consumer, accessibility refers to the geographic location of the resource and the related challenges to accessing it, while reliability refers to the risk of sudden supply disruptions.

7.4 Method

The research paradigm of this study is scientific realism. Scientific realism posits that knowledge can be gained by observing generative mechanisms in action (Pawson&Tilley, 1997:57). This study uses theory largely in a deductive, theory-consuming fashion. The theoretical framework of institutional interaction is used to help explain what kind of relationship exists between the EUETS and EES. The research design of this thesis is a single case study design, utilizing qualitative data from a literature review. It is used because case studies are well-suited to explore the existence of causal relationships and to give rich descriptions of their nature. It is a qualitative case study because the information necessary to answer the research question is mainly available in the form of qualitative data, but "qualitative" in this study does not denote the whole package[44] of methodological choices often assumed to accompany qualitative research. The data collection method chosen for this study is a literature review method. The purpose of employing the literature review method in this study is not to give a general overview of the literature, but to elicit from the large number of existing reports, papers and other publications on ES and on climate mitigation, cues about how the EUETS may influence EES. The sources for the literature review are peer-reviewed academic journals, grey literature as well as research anthologies and university textbooks. Grey literature denotes reports, working papers, policy summaries, analyses etc. from a range of organizations such as international organizations, government agencies, policy research consultancies as well as think tanks and industry associations. Guiding questions were used in order to select relevant passages from the material surveyed. Selection bias cannot be completely avoided because of the non-probabilistic sampling of material, but at the same time weighs less heavily because of less far-reaching conclusions and generalizations drawn from the material.

[44] The "qualitative research package" is often said to consist of an inductive or grounded theory approach to theory, an interpretivist epistemological position, and a constructionist ontological position (cf. Bryman, 2008:366, 593). This combination is common but not binding (ibid:23, 593)

7.5 Analysis and Conclusion

In the analysis chapter, each respective abatement category is analyzed for a) how it achieves climate mitigation, how it works and b) how it impacts on each of the sub-concepts of energy security. The analysis is carried out on data collected in a literature review in a textual fashion. It is filled with important details and reasoning and therefore difficult to summarize. The reader is strongly advised to read the actual analysis chapter and not only the summary table, since it is otherwise impossible to understand how the results were arrived at. The results of the analysis are summarized in the following table.

Figure 12. Summary of abatement categories' potential impacts on EES.

Abatement Category	Availability	Accessibility	Reliability
Natural Gas	indeterminate	trade-off	indeterminate
RES	positive	positive	short-term trade-off, long-term positive
Nuclear	short-term indeterminate, long-term positive	positive	positive
CCS	trade-off/ positive	indeterminate	indeterminate
Efficiency	positive	positive	positive

The analysis also argues that each case of institutional interaction between the two institutions should be categorized as behavioral interaction. Behavioral interaction posits that the behavior of actors (i.e. the operators), induced by the source institution (the EUETS), influences the target institution, in our case EES.

The study concludes that the EUETS *does* potentially affect EES, and that the effects depend on how operators choose to abate their emissions. The way this effect takes place is through behavioral interaction, and the type of impact varies considerably for each mitigation option. The study also concludes, that data on abatement needs to be published so that researchers can conduct a quantitative study to determine the actual rather than only the potential impact of the EUETS on European energy security.

8 References

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Appendix

List of Keywords used in Literature Search

Abatement
Cap and Trade
Carbon Capture and Storage
CCS
Climate Change
Climate Change Mitigation
Climate Mitigation
Climate Mitigation Options
Climate Policy
Climate Policy Integration
Emission Reductions
Emission Trading
Emissions Abatement
Emissions from Fossil Fuels
Energy Efficiency
Energy Policy
Energy Security
Energy Security Definition
Energy Security of Supply
Energy Security Policy
Energy Supply
Environmental Policy Integration
EU Climate Policy
EU Energy Policy
EUETS
EUETS Assessment
European Union Emission Trading System
Gas Energy Security
Gas Pipelines
GHG Emission Reductions
GHG Reductions
Greenhouse Gas Emissions
Impact Assessment
Incentives
Interaction
IPCC
Mainstreaming
Natural Gas
Nuclear Energy
Nuclear Energy Climate Impact
Policy Coherence
Policy Impact
Policy Integration
Policy Overlap
Renewable Energy
Renewable Energy Sources
Renewables
RES
RES-E
Security of Supply
UNFCCC