Report on the Qualitative Assessment of Climate Policies

Deliverable 2.5

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Abstract

This report is part of the project – "4i-TRACTION – Innovation, Investment, Infrastructure and sector Integration: TRAnsformative policies for a ClimaTe-neutral European UnION" which is funded by the European Union's programme "Horizon 2020". The aim of this project is to analyse what transformative climate policy could look like for the EU. To do that, an assessment of climate policies and their performance between 2005 and 2020 is needed. This document D2.5 'Report on qualitative assessment of climate policies' presents the results of a qualitative ex-post evaluation of the EU's climate policy for the period analysed. Based on the methodology detailed in 4i-TRACTION Deliverable 2.1., primarily through a review and evaluation of selected planning documents and legislation, a review of the literature, and interviews with experts involved in climate policy, this report, together with the quantitative assessment report, constitutes an integrated whole assessment of the EU climate policy for the period of 2005 - 2020.

A qualitative assessment of EU policy documents was made by evaluating the three objectives (3x20). Reducing greenhouse gas emissions by 20% in 2020 compared to 1990, achieving a 20% share of renewable energy in final energy consumption in 2020, and improving energy efficiency by 20% in 2020 compared to a reference scenario. The milestones that established the EU's climate policy were the Kyoto Protocol and the Paris Agreement. The study focuses on answering the question of which key transformative challenges have been addressed by policy documents at the EU level in the areas of innovation, investment, infrastructure, and integration.

In the area of innovation there was no significant emphasis on combining their development with the development of investment and infrastructure. We point out the inconsistency of this area with the environmental documents and the geographical disparities between Central and Southern Europe and Western and Northern Europe. In the area of infrastructure, we note that the assumption at the beginning of the analysis period (roughly until 2012) identified its development with the growth of the economic potential of individual regions and entire countries rather than with climate policy, which has become more intense over the years. In the area of finance, much more could have been done, as its role in financing sustainable investments grew over time - the closer we got to 2020, the bigger it became, but definitely not enough. In the area of investment, we point to the links between climate policy, broken down into the three cleats discussed earlier, and macroeconomic economic policy, transport policy, the impact on competitiveness, and issues such as health care, among others.

Finally, we discuss our findings, setting out the conclusions for future policy making in the context of current multi-crises. Our intention is that, by learning from the mistakes of the past, the future political process related to shaping decisions of a strategic nature on the EU level will be more effective, taking into account the lessons learned for the benefit of the planet, its climate, and the citizens who inhabit it.

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Abbreviations

Abbreviation	Description
ACER	European Union Agency for the Cooperation of Energy Regulators
AFID	Alternative Fuels Infrastructure Directive
CBAM	Carbon Border Adjustment Mechanism
CCM	Climate change mitigation
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CEF	Connecting Europe Facility
CEP	Clean energy for all Europeans package
CPI	Consumer Price Index
DH	District Heating
EAFRD	European Agricultural Fund for Rural Development
EC	European Commission
EDD	EU Ecodesign Directive
EDP	InnovFin Energy Demo Projects
EEA	European Environmental Agency
EED	Energy Efficiency Directive
EEEF	European Energy Efficiency Fund
EEG	European Essential Guarantees
EGUs	Electricity generating units
ENTSO-E	European Network of Transmission System Operators for Electricity
EPA	U.S. Environmental Protection Agency
EPBD	Energy Performance of Buildings Directive
ESD	Effort-Sharing Decision
ESR	Effort-Sharing Regulation
EU	European Union
EU ETS	EU Emissions Trading System

Abbreviation	Description
FIP	Feed-in premium
FIT	Feed-in tariffs
FQD	Fuel Quality Directive
GDP	General Domestic Product
GHG	Greenhouse gases
GTR	Green tax reform
ICAP	International Carbon Action Partnership
IMF	International Monetary Fund
JI	Joint Implementation
LCOE	Levelized Cost of Electricity
LCV	Light Commercial Vehicle
LPG	liquefied petroleum gas
MS	Member States
MSR	Market Stability Reserve
NCS	National Case Studies
NREAPs	National Renewable Action Plans
RED	Renewable Energy Directive
RES	Renewable Energy Sources
SDG	Sustainable Development Goal
SMEs	Small and Medium-sized Enterprises
TCCMP	Transformational climate change mitigation policies
TEN-E	Trans-European Networks for Energy
TEN-T	Trans-European Networks for Transport
TIS33	Technological Innovation Systems
US	United States of America

Executive summary

The assessment focuses on the achievement of the three key climate policy goals of the period in question, namely a 20% reduction in GHG emissions over the period of 1990 -2020, an increase in the share of RES to 20%, and a 20% improvement in efficiency.

The EU climate policy, which requires a very broad approach, was being implemented to such an extent for the first time, and there was no previous experience. Therefore, its formulation and implementation were in the nature of learning by doing. The formulation and implementation of climate policy instruments meant changes in thinking, this was what the climate and energy agenda required. All in all, it should be assessed that the climate policy of the period of 2005 - 2020 was successful, GHG emissions were significantly reduced and RES development took place but there has been no success in improving energy efficiency. However, some external factors have also played a key role. For example, in terms of GHG emissions, the financial crisis that started in 2008, led to a decrease in economic activity, and thus, in emissions. Also, it contributed to one of the main challenges in the period which has been the low prices of carbon allowances thorough most of the assessed period.

However, although the main targets have been achieved, some shortcomings and challenges have been identified. The policies' final design and implementation has been quite influenced by the idiosyncrasy of EU decision-making process and reaching consensus has come at a cost. In this regard, some of the policies lack the ambition and coherence needed. On a positive note, though, the 2005-2020 period has allowed gaining the needed experience to formulate better policies and amend some of the flaws and overcome some of the challenges. Also, it can be argued that the modest ambition of initial instruments has also played an important role in terms of gaining acceptability by all stakeholders involved, therefore allowing to progressively build a more robust and ambitious policy framework.

A key lesson from the 2005-2020 period as to climate policy is the need to create a coherent programme not only of substance, but also to communicate with the public, local governments and business. Currently, the European Green Deal is implementing this to some extent. People and companies, despite the fact that it is complicated and technical, feel that it is something needed and important on an ongoing and long-term basis.

What is needed is a comprehensive approach and the integration of climate into activities that at first glance are not addressed in the policy, such as finance, trade, health or education. For these purposes, it is important to introduce a mechanism to control virtually all decisions made from the point of view of the impact on GHG emissions or the need for adaptation measures. For this purpose, it is proposed to introduce a climate test of nearly all decisions made at both the EU and Member State levels.

1 Introduction

The 4i-TRACTION project examines the actual operationalisation of EU climate policy and its interconnections with initiatives done at the EU and national levels. It also offers examples for each of the "I"s and their evaluations. Operationalisation refers to converting abstract ideas into quantifiable observations on how national climate policies are being implemented. In addition, the case study analysis provides a suitable method for the 4i-TRACTION concept's assessment and operationalisation. A transformative approach to climate policy should make it easier to bring about the structural adjustments required to make our economies carbon neutral, so the 4i-TRACTION strategy has been used in WP2 to assist in resolving these problems. These four fundamental pillars of EU climate policy that encourage a shift towards a climate-neutral future are:

- Stimulating innovation to transform the material base of the EU economy,
- Rolling out the infrastructure for a resilient climate-neutral economy,
- Shifting investment and finance,
- Achieving integration of policies and technologies across sectors.

An ex-post assessment is a process of providing both qualitative and quantitative assessments to understand the performance of EU climate policies (Fujiwara et al., 2019). Qualitative assessment fills the gap by providing first-hand perception-based perspectives and placing quantitative assessment findings into context. Qualitative assessment can provide valuable insight into the performance of EU climate policies from the ex-post perspective and whether they have contributed to transformative change (Fekete et al., 2021). It examines stakeholders' experiences, policy contexts, and processes. The final aim of the assessment is to integrate collected material and findings from Tasks 2.1., 2.2., and 2.3., providing a context and broader understanding of practices behind the statistical findings of Task 2.1. and a national context of transformative change. Results will be converged to better understand the level of reaching of headline goal and practices. Because it might be difficult to combine assessments based on different approaches and data, the same collection of policy papers and regulations will be reviewed from both the headline and 4i perspectives. Using in-depth interviews, the goal is to contribute to the study's breadth by refining statistical findings. Through national case studies, thematic connections between the cases may be established thanks to the 4i's. Each analysis focuses on a different policy. The case studies were conducted in various nations, and the breadth of each case is unique to the subject it addresses. Even if the planned infrastructures for the two Member States are different, the suggestions at the European, national, and occasionally regional level from one Member State may be useful for the other. It takes into account local coordination, collaboration with various governmental levels, and collaboration across industries.

The challenge, over the analysed period, of various kinds of innovation and their potential contribution to the EU being carbon neutral by 2050 is one of the key aims of the climate policy, and the policies in this area were developed to help reach three primary targets:

- GHG emission reduction - 20% reduction in GHG emissions by 2020 compared to 1990;
- Renewables - 20% of energy from renewable sources in final energy consumption overall, 10% of energy from renewable sources for transport by 2020;
- Energy efficiency - 20% improvement in energy efficiency by 2020 to compared to reference scenario.

The study by Görlach et al. (2022) analysed the implications of transformational EU climate policy, identified four distinct policy avenues, and identified fundamental instruments. Experts believe market-based instruments have the most effect, while traditional regulation, innovation policies, and public investment are also included. However, the EU's policy mix does not acknowledge sufficiency and behavioural change, which are connected to the degrowth paradigm.

The structure of this report is as follows: the first part presents the role of qualitative methodology in the ex-post assessment of climate policies and describes the methodological strategy. Further sections provide the assessment for selected policies based on primary 2020 climate targets through the perspective of each of the 4i's. The final part presents conclusions of the provided ex-post assessment and recommendations based on the performance of EU climate polices during the period of 2005-2020 to the current, and future climate policy.

2 Methodology

2.1 Relevance of qualitative methodology for transformative climate policy

In order to create transformational climate change mitigation policies (TCCMP), policy evaluation is essential for two reasons (Schoenefeld and Jordan, 2019; Moore et al., 2021): timely policy monitoring is crucial given the urgency of the climate problem, and there is plenty of room for learning because TCCMPs are distinct from "regular" policies (Haddad et al., 2022).

TCCMP evaluation is difficult due to the time it takes for policies' true consequences to manifest. Systemic transformation is the goal of transformative policies, and finding relevant counterfactuals is difficult due to spill overs and phase-outs.

The qualitative approach aims to answer the following research questions:

- How and to what extent do EU climate policies deliver transformative change at the EU level (and at the MS level) in terms of the EU's 2020 climate and energy targets?
- What types of practices (and how) contribute to or undermine the transformative change of EU climate policies?
- How does the implementation of EU climate policies contribute to transformative change in terms of low-carbon investment flows, finance models, industrial innovation, and socio-economic outcomes?

This ex-post evaluation for the period between 2005 and 2020 focuses on the EU climate policies with a particular focus on effects related to the 4i challenges, such as stimulating innovation, rolling out infrastructure, shifting investment and finance, and achieving integration of policies and technologies across sectors. It also takes into account what is happening outside of the core area of EU climate policy, such as how the headline climate goals have been integrated into other policy areas.

The aim of this assessment is to better understand how and whether the EU climate policies between 2005-2020 have contributed to fulfilling the EU's 2020 climate and energy targets. The conclusions from this assessment will provide more insights into the state of the climate policy landscape in the EU and their input to transformative change. Moreover, it will be a step toward a debate about improving EU climate policies and their potential avenues in order to accelerate the transformative change in the future.

The methodological approach consists of three steps: a document review, an expert-based survey, and in-depth interviews. The document review aims to make a textual assessment, the expert-based survey provides their perceptions, and the interviews unpack the mechanisms behind the

performance of analysed EU policies. The successive steps of the qualitative assessment are presented in Figure 1.

Figure 1. Methodological strategy for ex-post qualitative assessment

The reasoning behind this whole methodological approach is that in order to capture the complexity of the performance of the EU climate policies, there is a need for the perception-based perspective. While the quantitative assessment focuses on understanding to what extent the EU climate policies have been reaching the 2020 climate and energy targets, the perception-based qualitative assessment aims to complement these results with a perspective that may show the complexity between various targets and relationship between different areas of transformative change (4i's). In other words, this qualitative assessment contributes to showing that the analysis of the EU climate policies and its performance with regard to the transformative change is not limited to reaching specific targets and their performance and potential added value (or unexpected barriers) may come to light as consequences of the interaction of these policies, the structural conditions, and stakeholders' attitudes. By selecting document analysis, survey and in-depth interviews, the intention is to cover various ways of capturing the perception-based approach.

The document analysis provides an overview of selected policies and provides ground for further stages that require the engagement of stakeholders. The survey provides a more comprehensive perspective on the perception-based assessment. Finally, the in-depth interviews allow for more detailed discussion that could be overlooked in the previous stages of the whole process. It allowed to look at climate policy from different perspectives.

2.2 Document review

The starting point for the ex-post evaluation of the documents was the preparation of a set of questions. The questions incorporated in this framework are based on the literature review, which assisted in determining whether materials exhibit the transformational shift described by the 4i's. The purpose of guiding questions is to better capture the depth, breadth, and pace of transformation of the EU's climate policies in each of the four 'I' dimensions during the review. The paradigm adheres to a mainstream policy analysis tradition that views policy as a problem-solving activity that delivers a solution under existing conditions (Colebatch, 2006). While the document review mainly is focused on the content of the policies, it also relies on the secondary analyses.

The goal is to determine how well policies perform in terms of transformative change in the first place, even though the question that lead the document review also reflect to categories available in the EU's Better Regulation Framework (effectiveness, efficiency, relevance, coherence, and added value).

The documents for the project are chosen based on talks with partners and appropriate assessments. While the EU's climate policy have changed during the analysed period (2005-2020), our strategy is to focus on more general areas of climate objectives understood as decarbonization, the increase of renewable energy sources in energy consumption, and the improvement of energy efficiency.

An important criterion for the selection of policies was that they related directly and, in the case of integration, indirectly to the mainstream EU climate policy in the period of 2005-2020. It is also important to emphasize that these policies were also taken into account in the quantitative assessment conducted as an integral part with the qualitative one (see Table 1).

Table 1. Selection of policies or legal acts for a detailed qualitative assessment

<table>
<tr><th>Key goals of the climate policy - 2020</th><th>Innovation</th><th>Infrastructure</th><th>Investment</th><th>Integration</th></tr>
<tr><td>20% cut in GHG emissions from 1990 levels</td><td colspan="3">- EU emissions trading system
- Effort Sharing Decision
- The Regulation CO_2 emission performance standards for new passenger cars and new LDV
- Fuel Quality Directive
- NER300 Programme</td><td rowspan="3">- Sustainable Consumption and Production and Sustainable Industrial Policy
- Common Agriculture Policy
- Circular economy action plan
- European transport policy for 2010: time to decide</td></tr>
<tr><td>20% of EU energy from RES</td><td colspan="3">- Renewable Energy Directive
- Alternative Fuel Infrastructure Directive</td></tr>
<tr><td>20% improvement in energy efficiency</td><td colspan="3">- Energy Efficiency Directive
- Energy Performance of Buildings Directive
- Ecodesign Directive</td></tr>
</table>

The text review of the documents served to categorise them and was done from multiple angles. Namely: the objectives, instruments, regulations and initiatives relevant to each of the 4i's. In addition, it assessed the implementation process, anticipated and the actual impact. As well as inconsistencies in a given document and the relationship between EU climate policy and other sectoral policies. The qualitative evaluation focus on the climate policy implemented rather than the alternatives provided by various research centres, institutions, and organisations. The review based on the expert-based judgment of the content also contribute to the interpretation of the content concerning the depth, breadth, and speed of the EU's climate policy transformative

change. The document analysis was also helpful for generating questions for two other steps of the analytical process: a survey questionnaire and an in-depth interview. The guiding questions are contained in Table 2.

Table 2. Guiding questions for document overview

Investment	Infrastructure	Innovation	Integration
To what extent have EU investment incentives succeeded in mobilising private funding for low-carbon investments, scaling up green finance, and preventing further investments into carbon-intensive assets? Have these policies been successful in closing the "investment gap" related to clean investments?	To what extent have EU-supported infrastructure investments been compatible with climate neutrality?	To what extent have regulations and incentives that support innovations in EU climate policies contributed to fostering new technologies that are compatible with the goals of climate neutrality?	To what extent have non-climate policies been aligned with climate policy objectives? Where / to what extent have increasingly ambitious climate targets led to the revision and adjustment of non-climate policies, strategies, and targets? Which practices can be considered incompatible with climate neutrality?
Do regulations and incentives related to EU investment offer any ways to encourage different sorts of actors to switch to less carbon-intensive activities (production, materials, infrastructure)? Do any of the investment-related regulations and incentives propose any direct or indirect impact on financial institutions and encourage them to mainstream climate-related issues into their operations? Do (and, if so, how) EU investment-related regulations and incentives address previously-identified administrative barriers and policy gaps that can undermine companies and other involved actors' climate-oriented transformation?	How do infrastructure-related instruments and regulations meet the existing level of ambitions in such areas as transport, heating, and electricity infrastructure during the period of 2005-2020? How are infrastructure policies coordinated with other sectoral strategies, and how are different types of (sectoral) infrastructure coordinated across Member States? Based on available knowledge and comparing to previous practices, how do infrastructure-related regulations concerning climate neutrality propose to contribute to creating added value for the economy (e.g. creating new jobs or a more effective value chain)?	Have regulations and incentives that support innovations in EU climate policies been meeting the existing level of ambitions (as of the period between 2005-2020) and which of them, based on available knowledge and practices, have been the most effective in stimulating clean innovations? To what extent do regulations and incentives that support EU climate policies promote the accelerated replacement of old technologies? Are they voluntary or obligatory? How well do regulations and incentives that support EU climate policies introduce proposals that lead	Based on available knowledge, to what extent have the objectives of climate policy mainstreaming policies been implemented in selected sectoral non-climate policies? How ambitious have these objectives been during the period of 2005-2020? How do selected non-climate policies address the commitment or the need for resources concerning climate policy mainstreaming? If they do address them, do selected non-climate policies propose instruments that control the lack of commitment/resources? Are they obligatory/voluntary measures to commit to climate goals? Are they introduced in parallel to the main instrument or regardless of the main instrument? Do non-climate policies have the necessary tools and competencies to create a regulatory environment supportive of sector coupling? Do non-climate policies propose the coordination of public and private sectors in an obligatory or voluntary form?

Based on available knowledge and comparing to previous practices, do EU investment-related regulations and incentives introduce some proposals that create a higher level of certainty for investors to invest in climate-neutral technologies during 2005-2020? Based on available knowledge and comparing to previous practices, to what extent have EU investment-related regulations and incentives introduced any proposals that directly or indirectly propose involvement in phasing out incumbent fossil technologies instead of only focusing on the addition of new low-carbon solutions during the period of 2005-2020?		to introducing potential new technologies to market maturity? To what extent have regulations and incentives that support innovation in EU climate policies been involved in shaping innovation ecosystems involving public and private research institutions, funders, entrepreneurs including start-ups? To what extent have regulations and incentives that support innovations in EU climate policies been considering changes in the production process, e.g. oriented toward a circular economy and greater material efficiency (e.g. the usage of lower GHG intensity materials)?
Additional questions based on key climate goals		
20% cut in GHG emissions from 1990 levels 20% of EU energy from RES 20% improvement in energy efficiency	Where does EU climate policy stand in terms of its progress towards the 4i's? Which of the 4i's are more or less advanced? How well are the 4i-related policies aligned with climate neutrality (or not), and where has there been most progress in recent years? To what extent is a given set of 'I' policies still relevant to current key climate goals (i.e. after 2020)? How effectively has a given set of 'I' policies been in progressing toward the current key climate goals? To what extent is a given set of 'I' policies coherent within its group and complement each other concerning the reduction of GHG emissions, the increase of RES energy, and the improvement of energy efficiency? (Are they neutral, complementary, or create the effect of synergy?) To what extent (and how) do a given set of 'I' policies have a prospect of success in terms of decreasing demand for energy, decreasing production, and exploitation of natural resources in a long-term perspective (2/5/10 years)?	

Synthetic results of the document evaluation conducted are included in Appendix A.

2.3 Expert-based survey

The second step was an expert survey to help us gather data from more stakeholders. The survey included not only "political" stakeholders (i.e. in EU bureaucracies in particular), but also social representatives (business representatives, and members of NGO sectors that deal with issues related to climate change, and local authorities). In this project, the survey stage relied on a standardised questionnaire with additional open-ended questions. Some respondents might struggle with the standardised approach, prevent them from going into great detail about how they felt about the topics covered in the questions. To be able to systematically compare respondents' opinions regarding transformational features of EU climate policy in terms of the 4i's across different nations and sectors of activity, we chose to place more emphasis on standardised questionnaires. Therefore, gathering more individualised narratives regarding EU climate policies was prioritised over the comparability of replies to specific questions. However, we believe that standardised questions may limit the perceptive assessment of experts, and we also provide room for open-ended questions.

The four survey questionnaires were designed with a dedication to one of the 4i's each. A single questionnaire was divided into questions that relate to headline climate goals: 20% cut in GHG emissions from 1990 levels, 20% of EU energy from RES, and 20% improvement in energy efficiency. These questions within each section refer to:

a) What were the ambitions of the policies associated with each "I" in relation to the main objective?

b) How complementary were the policies related to each of the "I's" in relation to the main objective?

c) How successful was the process of implementing the policies related to each 'I' with respect to the headline goal?

Moreover, each of these sections had a space for an open answer where respondents could share their reflections on ambitions, complementarity, and the implementation in relation to a specific headline goal that could not be expressed by standardised questions.

Considering the lengthy structure of the survey, each expert received only one questionnaire. The designed questionnaires aimed to take approximately 20-25 min to complete. Following the self-assessment of the community of experts regarding expertise in one of the 4i areas, each of them received one questionnaire.

The questionnaires are provided in Appendix B.

2.4 In-depth Interviews

Previous studies have noted that people in leading positions are less inclined to participate in surveys. Therefore, in-depth interviews with EU policymakers and their local counterparts

responsible for climate-related policies are suggested to complement the results of the survey. In-depth interviews will help to understand the perception-based assessment of the performance of EU climate policies in terms of their ex-post transformative change, capture how climate-related policies have changed over time, and complement the quantitative part of the project. The selection of interviewees was conducted with project partners and 4i leaders, and a semi-structured interview with open-ended questions allowed for a more exploratory approach. To check quality, the interview protocol went through a pre-testing process.

Despite the fact that the people interviewed represent different points of view, in order to get some comparability between them there are several themes that we tackle in the interviews:

- Whether during policy formulation all potential instruments to meet headline climate goals were exhausted. If not, why, and was it possible to formulate a policy to be more effective?
- Whether some gaps or barriers have appeared during the implementation of discussed policies. What challenges were observed during their implementation?
- What implication can be drawn from the period of 2005-2020 (in terms of ambitions, complementarity, and implementation) for a better formulation of climate policies in the future?
- How what has been identified in the EU climate policies during 2005-2020 can be understood in terms of the multi-crisis that Europe is currently facing (pandemic, war, energy, and economic crisis). How can the multi-crisis contribute to the transformative change of EU climate policies?

WiseEuropa, together with the University of Vigo, conducted 13 interviews and the results are included in a synthesised summary for each interview in the Appendix C.

2.5 Limitations and caveats

The process of the perception-based approach may face some limitations. In addition, there is a need to address some caveats to the whole process.

First of all, in contrast to objectively available data, relying on a perception-based approach may lead to different results depending on who is the respondent. Therefore, the difficulty of ensuring that all stakeholders will understand the questions and concepts in the survey and during the interviews in a similar manner, is embedded in the perception-based approach. At the same time, in some instances, even official statistics may elicit ambiguous interpretations.

Secondly, in terms of the document review, it is important to discuss the relation of guiding questions to the EU's Better Regulations Toolbox. Although the initial intent was to use the many categories offered by the EU's Better Regulation Toolbox for ex-post policy evaluations (European Commission, 2017), they may be challenging to evaluate from the perspective of transformative

change. The Better Regulation Framework is firstly concerned with establishing a link between the introduced intervention and the change that was noticed. However, finding a direct and causal link between a policy action and the actual change is challenging. Typically, in order to assert the existence of causation between phenomena of interest, one must rely on solid assumptions (Keele, 2015). It is crucial to stress that the research in this paper led to more associational than causal results.

Thirdly, we encountered many issues during the process of conducting the survey. Invitations to fill out questionnaires have been sent to the stakeholders that have expertise in areas related to a specific "I". However, the response rate was very low. To collect more responses, we aimed to expand the sample of invited stakeholders and sent various reminders. However, it turned out that the survey is too exhausting to attract respondents. Therefore, we decided not to rely on the survey. Instead, we decided to conduct more in-depth interviews that could provide a more comprehensive picture in terms of the perception-based assessment of the performance of EU climate policies.

However, the unsatisfactory rate of responses provides an important insight into future methodological approaches to studying a transformative change in EU climate policies. It seems that looking at issues related to the ambition level, implementation, and (internal and external) complementarity may be too complex for respondents. The survey also took an approach that is policy-oriented and thus it required respondents to have an extensive knowledge of legislation rather than the general approach of the EU towards EU climate policies (as was done for interviews). Thus, the survey may not be the best approach to understanding the performance of specific policies by looking at them separately. Instead, the process should have been more indirect. It means that questionnaires should have provided respondents with a package of issues that these policies address in order to make respondents assess how these issues have been solved at the EU level between 2005-2020.

3. Qualitative assessment of 2005-2020 EU Climate Policy

Task 2.2's goal is to qualitatively evaluate the various policies that the EU has undertaken between 2005 and 2020 in light of the demands and needs of a broadly conceived climate policy. The 4i-TRACTION strategy, which stands for innovation, investment, infrastructure, and sectoral integration, will be crucial to this assessment. Reviewing the quality of instruments/tools in relation to climate issues is essential to assess their effectiveness in EU policies. The presentation of the quality analysis is divided based on EU climate target for 2020: a) to reduce GHG emissions by 20% in 2020 compared to 1990, b) to achieve a share of 20% RES in final energy use in 2020, and c) to improve energy efficiency by 20%.

3.1 Target: to reduce GHG emissions by 20% in 2020 compared to 1990

3.1.1 Assessment of the design and implementation of the policy mix to reduce GHG emissions

In order to achieve the 20% reduction in GHG emissions by 2020, the EU and its Member States (MS) have designed and implemented several policies. In this section, the main overarching instruments (EU ETS and the ESD) and a selection of more specific and sectoral ones relevant for decarbonisation have been assessed.

The EU ETS is one of the main pillars of the EU climate policy. It was first established in 2005 by the ETS Directive with a three-year pilot phase followed by a second phase (2008-12), a third phase (2013-20) and the fourth and current phase (2021-2030). In each phase, the ambition levels were raised, and the mechanism was reviewed to correct the shortcomings identified.

The sectors covered up to 2020 were power generation, energy-intensive industries and, from 2012 on, also emissions from aircraft operators. Initially, only CO_2 emissions were included and from the second phase also, nitrous oxide (N_2O) and perfluorocarbons (PFCs) from the production of aluminium. It covers over 11,000 installations, around 45% of total GHG emissions.

In terms of impact, the EU ETS-covered sectors reduced their emission by around 35% between 2005 and 2021, thus contributing significantly to achieving and exceeding the overall emissions target reduction of 20% by 2020. However, this cannot be directly and exclusively attributed to the effect of the policy. In this regard, the economic downturn in 2008 or the rapid expansion of renewable energy, among other factors, have also contributed to this reduction. Additionally, seeing the low prices of carbon during most of the assessed period, a more robust price signal would have allowed achieving higher levels of reduction, considering the shortcomings of the policy as causing to miss an opportunity to reach more ambitious goals.

Carbon pricing instruments, in general, and emissions trading systems, in particular, have often been considered the most efficient way of internalising the social costs of emissions. However, some have challenged this notion by rejecting the idea that carbon pricing provides optimal results and can singlehandedly achieve the most ambitious decarbonisation goals (Lilliestam et al., 2021). Regardless of the diverging views in that debate, the design and implementation of the instrument play a significant role in its actual impact. It is highly complex to create and regulate a carbon market that contributes to efficiently achieving the set climate targets while at the same time achieving political consensus and maintaining competitiveness. The EU ETS, and its evolution from the initial stages, has been a clear example of this complexity.

As admitted by the European Commission (Evaluation of the EU ETS Directive - Publications Office of the EU, n.d.) and pointed out by academic literature (Sato et al., 2022), in the case of the EU ETS there has been a significant learning curve. The first phase was a pilot phase to test and

improve the system. In this regard, we have seen numerous reforms based on the reviews of the precedent phases. For example, moving from a Member-State-based to a centralised allocation system or moving from previous performance-based allocation to the use of benchmarks (which have in turn been redesigned).

Aside from limitations related to the instrument's characteristics, the EU ETS has also needed to be adapted to mitigate how external factors affect it. Clear examples of this have been the impact of the entrance in the market of the credits coming from the Clean Development Mechanism (CDM) from the Kyoto Protocol, the decrease in the price of energy from RES, or the 2008 global financial crisis. All these factors played a crucial role in keeping the price at very low levels for an extended period. The EC reacted to this fact by first creating a short-term solution which was the postponement of the auctioning of a total of 900 million allowances until 2019-20 (then transferred to the MSR). The long-term solution was the design of a Market Stability Reserve (MSR). The MSR entered operation in 2019 and, by holding or releasing a particular number of allowances following pre-defined rules, is expected to provide the necessary resilience to the system to face unexpected shocks. On this issue, the experts interviewed highlight the long time it took the EU to agree upon and implement a solution, considering the instrument as inflexible and not sufficiently resilient.

Another relevant issue to consider when assessing the EU ETS' level of success is the role of reaching political consensus. The instrument that was initially implemented in 2005 was the result of complex negotiations among the EC, the Member States and also the representatives of the economic sectors included in the ETS. That is, compromises that increased the political acceptability play an essential role in the final design. The aspect of social and political acceptability has been highlighted by several of the interviewees. Thus, what by some has been interpreted as lack of ambition, for others has been considered a necessary strategy to advance towards progressively more ambitious goals which would have face more vigorous opposition if suggested from the onset.

One of the concerns regarding the EU ETS has, from the beginning, been the risk of carbon leakage. One of the main mechanisms established from the beginning to mitigate the possible effects was the free allocation of allowances which has progressively been reduced but maintained for the free allocation of allowances which it has progressively been reduced but maintained for the sectors considered more at risk. The new strategy by the EC is the creation of a specific mechanism, the Carbon Border Adjustment Mechanism (CBAM) that is being finalised to be implemented in the current phase of the EU ETS. In this regard, it is interesting to look at the work by Colmer et al. (2023) who in a study on over 4000 companies in France have identified no signals of leakage. The study estimates a significant reduction in CO_2 per Euro of value added, but no reduction in total value added or employment which discards the possibility of the reduction being achieved via the externalization of emissions to non-regulated regions.

Overall, it can be argued that the first phases of the EU ETS, while not necessarily fully satisfactory in terms of its impact on innovation and low-carbon investment (See sections bellow), and thus

in decarbonization, have been instrumental in achieving a refined instrument that also has, with time, gathered the necessary consensus both at the public at private levels. As pointed out by Sato et al. (2022) some of the debates that led to substantial modifications during the subsequent reviews, where enabled by the experience in earlier phases. For example, the allocation 90% of allowances for free at the beginning was more palatable to private sectors.

The second main overarching policy is the Effort Sharing Decision later replaced by the Effort Sharing Regulation. As the political decarbonization targets have been updated, so have the reductions requirements for each MS. The Directive was adopted in 2009 as part of the Energy and Climate Package as Decision 406/2009/EC. It entered into force in June 2009 and set binding annual GHG emission limits for all EU Member States in the period 2013-2020, covering emissions in the transport, buildings, agriculture, small industry and waste sectors, most of the sectors not covered by the EU ETS. The overall EU-wide target was to achieve a reduction of GHG emissions in these sectors of 10% in 2020 compared +to 2005, promoting emission reductions in a fair and cost-effective manner. This 10% target was distributed among the MS according to their relative GDP per capita, so that MS with a relatively low GDP per capita could increase their emissions, while those with a relatively high GDP per capita had to reduce their emissions. Thus, the targets for the Member States ranged from a 20% reduction in emissions (Denmark, Ireland and Luxembourg) to a 20% increase (Bulgaria).

The decision defined a linear trajectory of corresponding emission caps (annual emission allocations) for each year between 2013 and 2020 and the MS were obliged to report annually on their GHG emissions and on their projected progress towards meeting their target. No specific targets were set for the different sectors covered, leaving the MS to choose where and how to achieve the necessary reductions. In addition, they could make use of flexibility instruments to meet their obligations. Thus, if a Member State's GHG emissions exceeded its annual allocation for one year, it could use upfront 5% of its annual allocation for the following year or buy allowances from other Member States, as well as use credits from international projects (Clean Development Mechanisms and Joint Implementation). Conversely, if a Member State managed to reduce its emissions in a year beyond what was needed, it could keep the surplus allocations for later use or transfer them to other EU Member States.

The annual emission allocations for each Member State and year were approved in October 2012 by the EU Climate Change Committee and adopted by the European Commission in March 2013, although in October 2013 they were adjusted to ensure consistency with the EU ETS, and in 2017 they were updated to ensure consistency with the latest international guidelines and methodologies for emissions reporting.

In October 2014, EU leaders set a binding global emissions reduction target of at least 40% in 2030, relative to 1990, which translated into a reduction target for the diffuse sectors of 30% in 2030 relative to 2005. To achieve this, the Effort Sharing Regulation (Regulation (EU) 2018/842) was adopted in 2018, which sets binding emission reduction targets for each Member State for the period of 2021-2030. As with the Effort Sharing Decision, the targets for each Member State

were set on the basis of their GDP per capita, however, to avoid some high-income MS having relatively high costs to reach their targets, these were adjusted to reflect the cost-effectiveness of MS with above-average GDP per capita. As a result, the 2030 targets for the EU Member States vary between 0% (Bulgaria) and -40% (Sweden and Luxembourg) compared to 2005 levels. This new regulation maintained the flexibilities existing with the Effort Sharing Decision, while introducing additional flexibility mechanisms such as the use a limited amount of EU ETS allowances to offset emissions in the diffuse sectors for some MS. Also, to stimulate additional action in the land use sector, MS can use up to 262 million credits from net removals related to land use, land-use change and forestry over the whole period of 2021-2030 to meet their national targets.

According to the Commission's impact assessment, most of the reductions in emissions since 2009 occurred due to technological and policy changes that enabled greater adoption of less carbon-intensive technologies. This effect was reinforced by the fact that the ESR was launched alongside other EU climate and energy initiatives as part of the 2020 package, in particular on energy efficiency and renewable (EC, 2016a).

A total of 24 EU countries (all except Cyprus, Ireland and Malta) had GHG emissions in 2020 in the diffuse sectors below their national targets under the ESD (EEA, 2022b) (see Figure 2). The Effort Sharing Decision contributed to emissions reductions in the companies covered by it, so that for each percentage point increase in the stringency of the policy at the national level, the emissions of an average covered company were reduced by 6.1%. Moreover, even in countries without stringent targets, emissions from covered companies tended to be reduced more than emissions from uncovered companies, so it is possible that the Effort Sharing Decision framework incentivised the adoption of policies and measures even in countries with lax targets (Gavard & Diethelm, 2022). This relates directly with the impact mentioned on the EU ETS regarding the effect the implementation of environmental policies, beyond their design, can have in the perception by stakeholder of the evolution of regulation stringency and thus in changing behaviour.

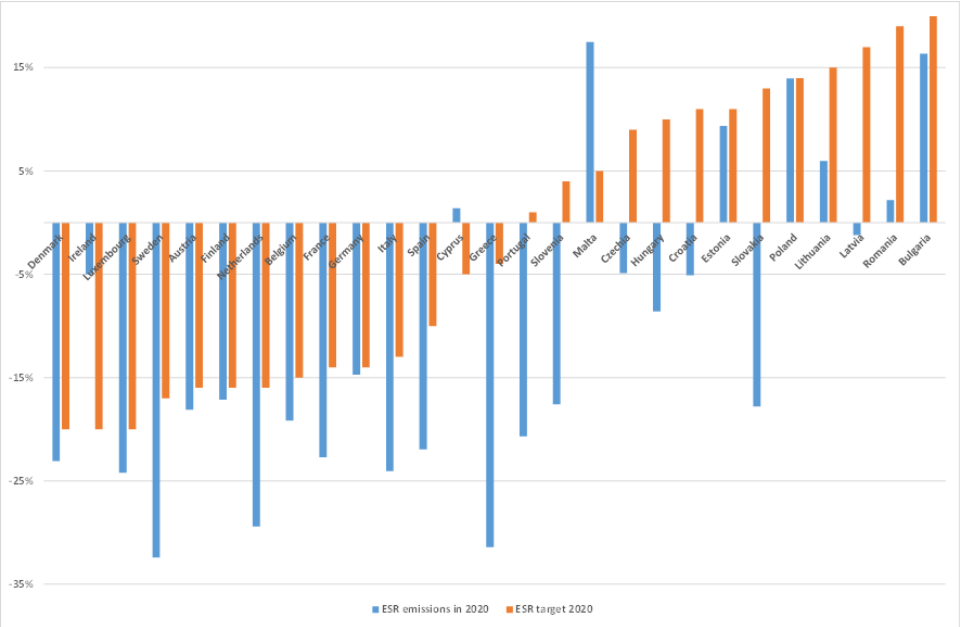

Figure 2. GHG Emissions of diffuse sectors in 2020. Variation compared to 2005

Source: EEA (2021, 2022[a]) and authors

As highlighted in the case of the EU ETS, although the targets were largely met, there have been major conjunctural factors such as the economic downturn that made the achievement of goals more accessible irrespective of the measures taken by each state. Additionally, in the case of the ESD, it sets a global target for the affected sectors, but it does not prescribe how to pursue them and also, it coexists with a number of instruments implemented at EU, national or subnational levels. This makes it difficult to isolate and quantify the specific impact of the policy.

However, the challenge of quantifying does not mean the policy did not have an impact. From an EU policy perspective, the coordination and agreement of emission targets for each MS at the Community level does have a value added and it is unlikely that emission reductions would have reached the same level without the instrument. Thus, the ESD has stimulated the implementation of policies at the national level to meet the goals and also the existence of a Monitoring Mechanism Regulation, although with its own limitations, has provided a framework to monitor and report measures taken by MS.

The fact that mechanisms to achieve the target are decided at each MS level provides the advantage of being able to adapt the measures to the characteristics of each country. However, this also entails a risk of having disconnected approaches. Coordination among countries in sectors like energy and infrastructure is key to achieve climate neutrality (Görlach et. al., 2022). Thus, this coordination needs to be sought with additional policies such as TEN-E and TEN-T, that ensure the connection and coordination of transborder interventions.

As mentioned above, these two transversal and overarching instruments are complemented by a set of more specific instruments that have been deployed in the 2005-2020 period. These

instruments target either a sector, a specific challenge or both. For this assessment, some representative ones have been selected to see how their implementation has been carried out and to assess their degree of success and what lessons can be, and have been, learned to inform and enhance climate policy instruments. The selected policies are the Alternative Fuel Directive, the Fuel Quality Directive, the regulation CO_2 emission performance standards for new passenger cars and new LDV, and the NER 300 Programme.

The Alternative Fuel Infrastructure Directive (Directive 2014/94/EU) is a good example of the need of developing adequate infrastructure to enable the uptake of new technologies that need to replace more carbon-intensive ones. The Directive obliges Member States to develop standards for developing public refuelling and recharging points for vehicles and vessels using alternative fuels, with the aim of minimising transport's dependence on oil and mitigating the environmental impact of transport. To this end, it establishes minimum requirements for the development of alternative fuels infrastructure, including charging points for electric vehicles and refuelling points for natural gas and hydrogen, to be implemented through Member States' national action frameworks, as well as through common technical specifications for such points and user information requirements. Thus, each Member State adopted a national framework for action for the development of the market for alternative fuels in transport and the deployment of the corresponding infrastructure.

Although limitations have been pointed out regarding the capacity of the instrument to achieve the set goals, this Directive, in combination with other legislative initiatives, has had a considerable impact on both the uptake of alternative fuel vehicles and their infrastructure. Thus, the share of sales of alternative fuel vehicles in 2020 is slightly higher with the Directive than in a scenario without the Directive, and this positive effect will increase significantly towards 2030. It has also had a direct impact on the number of electric charging points, which is expected to be about twelve times higher in 2030 than without the Directive, and a similar impact is expected for LNG and hydrogen refuelling points. However, investments in alternative fuels infrastructure in ports have been limited in most Member States. Finally, another key goal of the Directive was interoperability. The compatibility of charging infrastructure among MS is important both in terms of climate policy and also in terms of free movement of persons and goods. the Directive has had a considerable effect on the interoperability of alternative fuels infrastructure, although a number of shortcomings still prevail that could hamper the smooth movement of users across borders, especially with electric vehicles (European Commission, 2021b).

As part of the "Fit for 55" package, the European Commission proposed in 2021 (European Commission, 2021a) to repeal the Directive and replace it with a Regulation to ensure a rapid and coherent development of the infrastructure network across the EU. This regulation sets a series of mandatory national targets for the deployment of alternative fuel infrastructure in the EU for on-road vehicles, boats and stationary aircraft, requiring Member States to expand charging capacity in line with sales of zero emission cars, and to install charging and refuelling points at regular intervals on major motorways.

The regulation on CO_2 emission performance standards for new passenger cars and new LDV is a good example of the use of standards as a policy instrument in the EU. In this case the standard is directly set by the Commission and directed to private stakeholders, specifically car makers.

Regulation (EC) 443/2009 of 23 April 2009 set CO_2 emission performance standards for new passenger cars, while Regulation (EC) 510/2011 of 11 May 2011 set CO2 emission performance standards for light commercial vehicles. Thus, they set a target for the new passenger car fleet of average emissions of 130g of CO_2/km from 2012 and 95g of CO_2/km from 2020, while for light commercial vehicles the targets were 175g of CO_2/km average CO_2 emissions from 2014 and 147g of CO_2/km from 2020. Each year, each passenger car or light commercial vehicle manufacturer had to ensure that its average specific CO_2 emissions did not exceed its specific emissions target. These targets were calculated as the average of the specific emissions of each new vehicle registered by the manufacturer in each year, with the specific emissions of each new vehicle calculated taking into account the mass of the vehicle.

Manufacturers could form pools to meet their obligations and, if they exceeded their emissions target in a given year, they had to pay an excess emissions premium of EUR 95 per g/km of target exceedance for each newly registered passenger car or light commercial vehicle. However, manufacturers could apply for an exemption from the specific emissions target if they were responsible for registering fewer than 10,000 new passenger cars per year or 22,000 new light commercial vehicles per year and submitted a specific emissions target consistent with their reduction potential.

It has been estimated that these regulations achieved an annual emission reduction rate of between 3.4-4.8g of CO_2/km for new cars, while for light commercial vehicles, fleet-wide average emissions exceeded the required target by 2017, and the rapid pace of emission reductions suggests that the regulation played an important role in accelerating these reductions (Kollamthodi et al., 2020). As a result, the regulations were responsible for a reduction in total emissions from new cars entering the fleet between 2006-2013 of 138 million tonnes CO_2, while for new light commercial vehicles entering the fleet between 2009-2013, the reduction was 5.2 million tonnes CO_2 (EC, 2015).

Emission standards set quantitative limits on the amount of emissions allowed. Within the instruments of environmental policy, they belong to the so-called mandate and control regulations, taking the form of conventional regulation of economic activity, through the establishment of mandatory standards for polluters. This type of instrument is the most widely used in environmental policy, due to its apparent environmental effectiveness and its adaptation to the dominant legalistic approach in public policies, as well as usually having the support of economic agents, who consider them to be more stable and a clear guarantee of compliance with certain environmental objectives. However, they present problems, as they are unable to achieve efficient results, both statically and dynamically (Labandeira et al., 2007). From the static point of view, since there is asymmetric information on the costs of decontamination between the regulator and the regulated party, the latter has incentives not to disclose its true costs, which

forces the regulator to use a uniform approach that does not distinguish between polluters, causing the total costs of achieving a given level of decontamination to be higher than strictly necessary. From a dynamic point of view, polluters have no incentive to improve on the limits set by the regulator, so they have no incentive for continuous technological innovation. (see Baumol & Oates, 1988).

The ex-post evaluation of these regulations (EC, 2015) showed that they were effective in reducing CO_2 emissions from new cars and light commercial vehicles. Thus, they are likely to have enabled between 65%-85% of the reductions in car exhaust emissions achieved after their introduction, also playing an important role in accelerating the reduction in emissions from light commercial vehicles. In addition, the regulations were more effective in reducing CO_2 emissions than the voluntary agreements between the car industry and the European Commission in force between 1998 and 2009, and were more cost-effective than expected in achieving the targets set.

However, these regulations only set emission targets until 2021 for passenger cars and until 2020 for commercial vehicles, and therefore did not provide sufficient incentives to further reduce vehicle emissions at the rate necessary to achieve EU climate targets, in particular to invest in alternative propulsion systems (EC, 2017), so in January 2020 a new regulation (Regulation (EU) 2019/631) entered into force setting new CO_2 emission targets for new passenger cars and light commercial vehicles applicable from 2020, 2025 and 2030. From 2025 onwards an EU fleet-wide target is set for average fleet emissions of both new passenger cars and new light commercial vehicles equal to a 15% reduction of the 2021 target; while from 2030 onwards the target rises to a reduction, compared to the 2021 target, of 37.5% for passenger cars and 31% for light commercial vehicles.

In 2021, as part of the 'Fit for 55' package, the Commission presented a proposal to revise Regulation (EU) 2019/631, setting more ambitious standards (EC, 2021). This proposal includes an increase of the emission reduction targets for the EU car fleet in 2030 to 55% for new passenger cars and 50% for new light commercial vehicles, compared to the 2021 target. In addition, a target of 100% reduction of the 2021 target is set for both passenger cars and light commercial vehicles from 2035 onwards. In February 2023 the European Parliament approved these new standards (see European Parliament, 2023).

The Fuel Quality Directive (Directive 98/70/EC of 13 October, as amended by Directive 2009/30/EC of 23 April) regulated both the specifications for fuels content, acting as a standard, and also establishing maximum emissions targets for theses fuels. It lays down, in respect of road vehicles and non-road mobile machinery, technical specifications, on grounds relating to health and the environment, for fuels intended for use in their engines, taking into account the technical requirements of those engines. These specifications set maximum and minimum limits for certain components of fuels, but do not require fuels to be chemically identical, allowing the MS certain options with respect to national requirements for the marketing of these fuels. In addition, it sets a lifecycle greenhouse gas emissions reduction target for these fuels. Thus, its two main objectives

are to ensure a single market for fuels in the EU and to guarantee minimum levels of environmental and health protection in relation to their use (Green et al., 2017).

The Directive states that Member States should require suppliers to reduce as gradually as possible life-cycle greenhouse gas emissions per unit of energy supplied from fuel and energy supplied by up to 10% by the end of 2020, compared to the baseline in 2010. This reduction consists of a 6% reduction by 31/12/2020 (interim targets of 2% by 31/12/2014 and 4% by 31/12/2017 may be required), plus an additional indicative target of 2% achieved through the supply of transport energy for use in the above-mentioned vehicles and/or through the use of any technology capable of reducing life-cycle greenhouse gas emissions per unit of energy of fuel or energy supplied; as well as an additional indicative target of 2% achieved through the purchase of credits under the Kyoto Protocol's Clean Development Mechanism.

In addition, it introduces sustainability criteria for biofuels, so that energy from biofuels will only count towards the emission reductions mentioned above if it meets a number of sustainability criteria. Furthermore, these biofuels may not be produced from raw materials from land with a high biodiversity value or high carbon stock, or from raw materials extracted from peat land.

The requirements of the Directive have evolved over time with the introduction of new fuel specifications and reporting requirements. The first specifications for petrol and diesel for road transport in the EU entered into force in 2000, as originally planned, and included the key provisions of a lead ban and limits for benzene and aromatics in petrol, as well as for sulphur in both fuels. In 2003, the Directive was amended by Directive 2003/17/EC10, with the aim of improving air quality standards and facilitating the reduction of GHG emissions by reducing the permitted sulphur content. Subsequently, in 2009 it was also amended by Directive 2009/30/EC, mainly to encourage the reduction of GHG emissions. To this end, a GHG intensity reduction target for fuels placed on the market was introduced, in addition to adjusting the specifications regarding the use of biofuels blended with petrol and diesel. Fuel specifications were also extended to inland waterway transport. In 2011, Directive 2011/63/EU introduced the possibility to derogate from the vapour pressure for the blending of ethanol in petrol, while in 2014 Directive 201/77/EU introduced a specification of the test methods to be used by Member States in the monitoring of fuels. Finally, in 2015, Directive (EU)2015/1513 amended the provisions in relation to biofuels.

This Directive was effective in creating the necessary conditions for the development of markets for biofuels and other fuels with lower greenhouse gas emissions intensity. However, in the view of stakeholders consulted in the impact assessment conducted by the Commission, the Directive has not yet contributed to the expected social and environmental impacts and has not given a new impetus to the technological development of more efficient engines. Factors hindering the achievement of the targets include the inconsistency of the regulatory framework (mainly due to inconsistency with the Renewable Energy Directive) and the low expected return on investments made by suppliers/producers to reduce GHG emission intensity. In addition, the lack of national support schemes is another barrier to investments, while other difficulties include the insufficient availability of sustainable feedstocks and the lack of harmonisation of national transpositions and blending obligations in those MS that have chosen to introduce them in their national legislation. This reduces both supply and demand for fuels with lower GHG emission intensity and therefore slows down their uptake and the achievement of the Directive's targets (Lo Piparo et al., 2021).

In 2018, the vast majority of the EU Member States were below their mandatory 2020 target of a 6% reduction in lifecycle GHG emissions intensity and the indicative 2017 target of a 4% reduction relative to 2010 levels. Thus, on average for the EU, GHG emissions intensity had been reduced by 3.7% compared to 2010, and only two EU Member States (Finland and Sweden) had reached the 2020 target, while three others (France, the Netherlands and Poland) had reached the indicative target for 2017. Within the countries that had not reached the 2020 target, the distance to the target ranged from 1.4% in Poland to 5.9% in Croatia (Lo Piparo et al., 2021).

The last assessed policy is the NER300 funding programme, which has a much more specific focus, but is of interest both for its innovative approach in terms of funding and its role in promoting innovative breakthrough low-carbon technologies. NER300 stands for New Entrant Reserve 300, referring to the 300 million carbon allowances set aside by the EU from the third phase of the EU ETS for the programme. It focuses on Carbon Capture and Storage (CCS) and innovative renewable energy technologies (RES). The legal basis of NER 300 was established in 2009 by the revised ETS Directive (Art 10a (8)), but the criteria and rules shaping the design were adopted in 2010 through the Decision 2010/670/EU.

The Programme was divided in two different calls, one in 2012 with a total budget of the equivalent to 200 million allowances and the second, in 2014 with a budget of 100 million allowances. In the first call 20 RES projects were selected totalling 1.1 billion Euros. The awarded projects in the first call reached final investment decisions by December 2016 and had a starting date deadline of December 2019. In the second call, 18 RES and 1 CCS project were selected with a total amount of 1.1 billion Euros. Final investment decisions for these projects were reached by June 2018 and projects were expected to start no later than June 2021. However, not all awarded projects have ended up starting as securing the additional funding has proved challenging. The only CCS project was one of the withdrawn ones.

The NER300 programme, and now the Innovation Fund, have to be contextualised as one of the pieces in a broader group of funding instruments and programmes that promote technological innovation at the EU level. Other programmes, each with a different focus, include the Horizon2020/Horizon Europe Framework programme, the Modernization Fund, the Connecting Europe Facility or the LIFE programme among others.

The NER300 Programme has provided some interesting insights in terms of policy design and funding of innovative technologies. In terms of policy design, one key takeaway is the fact that some of the features of the policy that seek to achieve a particular goal such as, for example, territorial balance, can affect the main goal of the policy. In this case, the sub conditions of the call have somewhat altered the results of the policy.

From the perspective of the effectiveness and efficiency of the policy, we see how although a very important sum has been allocated to promote innovation, there have been some barriers that have slowed down the process and caused some funds to be unspent. The due diligence process has been very long and finding the matching funds has proved to be challenging. Considering that the instrument was supposed to ease the path for projects that in market

conditions would face many risks and uncertainties, probably some of the features should have been designed to provide more flexibility and allow for a swifter process altogether.

Also, the assessment of the NER300 Programme serves as an example of the interdependence among different policy instruments. In this case, the link to the EU ETS via the price of the auctioning of the allowances, substantially affected the policy as, as mentioned, the available funds were significantly reduced compared to the expectations. The risks of linking different policy instruments and the according mitigation measures should be considered in the policy design.

The Innovation Fund, that takes over the NER300 Programme, has taken stock of some of these challenges. Thus, the NER300 has had a positive role in providing the know-how to implement this type of innovation promotion policy in an effective and efficient way.

3.1.2 Main insights from the 4i perspective

The 4i Traction Project structures and identifies the main challenges of climate change mitigation around 4 areas: Innovation, Investment, Infrastructure, and Integration (Görlach et. Al., 2022). In this section we assess the abovementioned policies according to each of these challenges.

3.1.2.1 Innovation

Promoting innovation is one of the key mechanisms through which a carbon market can achieve decarbonisation goals. The progressive scarcity of allowances created by the decreasing cap generates a rise in the price carbon increasing the incentive to switch to alternative technologies. The advantage of a carbon market is that the reduction of emissions takes place where the cost is the lowest.

In the case of the EU ETS the main challenge has been, for most of its existence, to achieve a balance among the demand and the allocation of allowances mechanism to keep a high enough price signal (see Figure 3) that would indeed incentivise in a significative way the reduction of emissions among participants through innovation (MARCANTONINI et al., 2017).

Figure 3. Evolution of EU ETS allowance price 2005-2022.

Source: ICAP 2022[1]

It is complex to isolate the specific impact of the EU ETS in promoting innovation as it coexists with other policies at the EU and national level that also contribute to this goal. The literature that has studied the issue points towards a positive, albeit modest, impact on technological innovation (Evaluation of the EU ETS Directive - Publications Office of the EU, n.d.; MARCANTONINI et al., 2017; Sato et al., 2022). There are also other market inputs, such as fuel prices for example, that can also incentivise or disincentivise innovation as well as the economic context. In this line, Calel & Dechezleprêtre (2016) point out the fact that the main source of emissions reductions in the first phases was fuel switching in energy production which does not require new technological innovation and is based on organisational decision-making.

A distinction pointed out in the literature is among stimulating innovation and its adoption and diffusion. In this sense, studies have found that the EU ETS has been more effective in incentivising innovation and less so in the diffusion aspect, where targets and standards might have contributed to a greater extent.

Beyond the price signal, which, as we have seen, has been low, the existence of a framework and the expectations of a future with a more climate-stringent policy context can also trigger changes in behaviour. Thus, when a company expects to face higher prices on emissions, it provides an incentive to proactively make operational changes and invest in reducing the carbon intensity of their output (Calel & Dechezleprêtre, 2016). That partly explains the effect on innovation observed by empirical works. However, the uncertainty and lack of predictability of prices in the case of the EU ETS in the studied period have also prevented a stronger impact in this regard.

In the case of the ESD, the incentive on innovation comes through the setting of an emissions reduction target which conditions maintaining or increasing production volumes to the switch to less carbon intensive processes and technologies. However, the effect is harder to detect since

this reduction of emissions can come from innovation-related changes, but also can be related to energy efficiency measures among other. Additionally, the downturn of the economy from 2008 on, led to general decreases of emissions related to lower production levels. The impact on innovation has also been dependent on the specific measures each MS has opted for to achieve the reduction targets. The difference in the target stringency among MS, including some states with positive emissions targets, has also provided very different inputs to incentive innovation in the different contexts.

Measures adopted by the MS include voluntary or negotiated agreements with industries to encourage them to voluntarily adopt energy saving and efficiency measures, offering incentives such as tax reductions or exemptions in return. These measures may have contributed reduce barriers to innovation and technology adoption by stimulating the early market for high-efficiency technologies in industry (AEA, 2012).

Thus, similar to the EU ETS, the incentive to innovate is generic and poorly targeted. This means that while improvements may be cost-effective, they do not necessarily contribute to the coherence and coordination that is assumed to be required to achieve the new, much more restrictive decarbonisation targets.

The other four policies assessed have a more targeted approach to innovation. In the case of the Alternative Fuel Infrastructure Directive the policy contributes to the diffusion of cleaner technologies. This often requires actions beyond the product development itself, as is the case with new fuel sources for transport. As mentioned above, the Alternative Fuel Infrastructure Directive sets requirements for the availability of charging stations, and natural gas refuelling. Thus, having a widespread and dense network of charging stations is a key element for the general public and the transport sector to consider shifting to new technologies with the minimum impact on their behaviours.

The importance of the measure is also linked with the need of this actions to be taken not from an individual perspective but from a strategic and coordinated one within MS and among MS. This is where the Directive seems to fall short.

The regulations on CO_2 standards for cars and vans directly promotes innovation by establishing a reduced emission standard that needs to be met industry-wide. According to the impact assessment commissioned by the EU it allowed for accelerated research and development of fuel-efficient technologies, as well as increased market adoption of fuel-efficient technologies in both passenger cars and light commercial vehicles. (EC, 2015).

In addition to the final targets, the regulations included so-called super-credits in their first years, so that each new passenger car with specific CO_2 emissions below a threshold in the first years counted more than double towards meeting the target. These measures provided an additional incentive for producers to develop and bring low-emission vehicles to market quicker but could weaken emission reduction targets by allowing manufacturers' average actual emissions to be higher than their targets, which could have delayed the introduction of fuel-saving technologies

for all types of vehicles. However, in practice, the super-credits were not necessary to meet the targets, so they did not weaken them (EC, 2015). This suggests that probably the ambition of the policy, and thus the standards proposed, were not as high as they could have been.

Similar to the Alternative Fuel Directive, the Fuel Quality Directive's mechanism to incentivise innovation is by setting specifications requirements, in this case linked to the emissions of fuels. The Directive has indirect effects on innovation, stemming from the development of different fuel market sectors and associated technologies (Department for Transport, 2011) to achieve fuel emission reduction targets. In addition, it includes an indicative target of a 2% reduction in GHG emissions from fuels that can be achieved through the use of any technology capable of reducing lifecycle GHG emissions per unit of fuel energy or energy supplied, thereby stimulating technological innovation in this field. However, the Directive does not include specific specifications for non-conventional oil (Transport & Environment et al., 2010), whose GHG emissions are much higher than those of conventional oil, reducing incentives for innovations in cleaner and more efficient production methods.

Finally, the NER300 programme, although not a primary policy, plays an important role in the EU climate policy mix and specifically in terms of promoting innovation linked to decarbonization technologies. Whereas the EU ETS has a more central role by trying to incentivise innovation in a cost-effective way via carbon pricing, the NER300 Programme focused on supporting a set of specific technologies with potential in playing an important role in the decarbonization of economies. The Programme focuses on the demonstration and early deployment phases which have been considered critical by the specialised literature on innovation as it is often the steps where new initiatives fail (Åhman et al., 2018).

One important feature of the Programme from the innovation perspective is that it is technology specific. The advantage of top-down approaches, compared to bottom-up ones, is the possibility to invest a large amount of resources in one, or a few, selected technologies giving a high intensity of resources that can lead to faster breakthrough results. The risk, however, is that if the selected technologies end up not being viable, then the investment is lost. As mentioned before, the EU combines both approaches and within its R&D funding schemes also has bottom-up funding opportunities like, for example, in the EIC calls under the Horizon Europe Programme. Also, these programmes focus on different stages of the innovation process.

It is interesting, though, to understand how the technologies selected were decided upon. Initially, within the political debate around 2008 that led to the NER300, the idea from the EC was to focus only on CCS. Specifically, there was the idea of having 12 CCS demonstrating projects running by 2015. However, some Member States opposed this idea and pushed to open the scope to also include innovative RES technologies (Åhman et al., 2018). With the operationalisation of the programme in 2010 the areas of CCS and innovative RES technologies the NER300 the technologies eligible for funding were further detailed.

Looking at the results of the two calls for proposals, we can see however that, RES projects have practically been allocated the totality of available funds with, as mentioned above, only one CCS

project funded in the second call but that did not manage to secure the additional funding and thus did not continue. The reasons for the failure to fund CCS projects are further discussed below within the investment assessment.

These results bring up two relevant issues. On the one hand it is worth noting that the decision of which technologies are included does not solely rely on technical or feasibility criteria, but it also has a substantial political component. Thus, political bargaining has ended up having a big role in how the programme has been shaped. Secondly, the design of the instrument, together with the impact of external factors, has unintendedly ended up shifting the investments away from the original target of the policy, CCS.

On a more specific and technical level, also linked to technology specificity, one of the comments made in the context of the impact assessment for the Innovation Fund was that the fact that there was such a specific categorization might have inhibited the search of hybrid solutions that might have led to positive results (EC, 2019). In the Innovation Fund, the successor to the NER300 Programme, the eligible technologies have been broadened by also including industrial solutions.

An important feature of the NER300, related to innovation, is the knowledge sharing requirement included in the legal framework of the Programme. Funded projects must share the relevant knowledge acquired during the development of the project. Two levels of information sharing have been defined. One, with more sensitive information, only shared with other projects within the same technology subcategory and the other publicly shared. The knowledge sharing by projects needs to be reported annually to the EC and disbursement of funds is made conditional to fulfilling this obligation (JRC, 2022). Knowledge sharing reduces risks for projects working in similar technologies and also contributes to a better utilization of public funds dedicated to innovation. This feature aligns with the growing priority of the EC to provide, to the possible extent, open access to results of publicly funded research and projects.

Beyond technological innovation, the NER300 Programme can also be assessed from a policy innovation perspective. The most innovative aspect is the way funds are obtained. The decision to dedicate the revenue from the auctioning of a certain amount of allowances (in initial talks 500 million allowances, later reduced to 300) to innovation projects allowed to attract additional funding, independent from the EU standard budget. However, this came with the risk of the variable prices of allowances in the ETS which did not allow to specifically determine the amount of available funds.

Thus, we see how the EU climate policy focused on GHG emissions reduction, is formed by an array of policies and instruments in which innovation plays an important role. We see how broader overarching policies such as the EU ETS and the ESD affect innovation in a more indirect way. Then other more specific policies such as the Alternative Fuel Infrastructure Directive, the Regulation on CO_2 standards for cars and vans or the Fuel Quality Directive complement them by providing more specific inputs that lead stakeholders to engage in innovation. For some of the interviewed experts there is a too fragmented approach with too many bits and pieces that did

not allow to achieve the expected results in terms of innovation. According to this perspective a mission-oriented approach is necessary.

The shared assessment among academic literature, the policy assessments and the results of the interviews is that while the general targets, in this case the reduction of emissions by 20% has been met, the capacity of policies to incentivise innovation has been limited. In some instances, such as in the standards and targets it is suggested that there has been a lack of ambition in setting some of the goals, while some problems in the policy design might have also contributed to this modest impact. However, as mentioned in other sections, the assessed policies have often been reviewed and reformulated to improve their efficiency and adapt to new more ambitious targets. Thus, again, there has been at least important lessons learnt and acquired experience that has served to improve current instruments.

3.1.2.2 Investment

In terms of investment, regarding the EU ETS, the existing evidence suggests that, in its first phases, it was able to incentivise some short-term incremental investments, with short amortization times, but less in terms of large investments (Teixidó et al., 2019). The concern of with this type of smaller investments is that, while probably cost-effective, they are not sufficient to meet stronger intermediate targets and to achieve decarbonization by 2050.

Additionally, according to Gulbrandsen & Stenqvist (2013) other market factors, notably the cost of raw materials and especially energy costs, were far more important factors in investment decisions.

Also, as pointed by Patt et al. (2019) for near-term reductions to be more significant, beyond the cost criteria, they need to be compatible and aligned with the overall needed effort to advance towards technology changes that allow the decarbonisation of our economies. However, there is the challenge of the inertia of current production systems that can easily turn into technology lock-ins. Bringing it down to a specific example and the EU context, fossil fuel technologies, benefiting from its maturity, existing infrastructure and share in the market have been able to provide more cost-effective reductions in energy savings that certain investments in alternative less carbon-intensive alternatives.

Taking the above into consideration, for new technologies to be widely adopted they not to be actively supported and funded to create a level playing field and also innovation of fossil fuel-based technologies needs to be pursued. The EU ETS needs, thus, to be complemented by policies that enable a transformative change by both enabling large scale investments and directing them towards new technologies. In this regard, the NER300 and Innovation Fund, like in the lower TRLs and more downstream policies like the RES Directive act as these supporting instruments that should enable achieving climate neutrality.

A closely linked issue in terms of promoting substantial investments is also the expectation related to the future conditions. As highlighted in the when we referred to innovation, If the perception

is that there is a more stringent context ahead, with lower allowances levels and higher prices there is an incentive to undertake longer-term investments. However, this also needs to be accompanied by clear stability signals. That is, the system needs to be robust and provide certainty to investors to allow for larger and riskier investments that can, in turn also provide larger CO_2 reductions. Thus, uncertainty about climate impacts, future policies and evolving technology can delay the investments needed to achieve climate change mitigation. At the same time, an increase in mitigation and adaptation activities lowers the risks for a country, as policy makers can reduce overall uncertainty by providing certainty about policy objectives. (Paltsev, 2019).

In the case of the EU ETS this has been one of the main challenges in the studied period that seems to have prevented from having a more significant impact. As prices haves steadily increased since 2020 (see figure 3) and the MSR and other mechanisms seem to have managed to provide higher price stability, it will be interesting to see whether the impact in terms of investments is also stronger.

As per the Effort Sharing Decision, the stakeholder consultation conducted as part of the impact assessment identified as a barrier to achieving the targets identified the lack of availability of financial resources to invest in mitigation actions. Although the economic recession contributed to achieving GHG emission reductions in the diffuse sectors, austerity measures may have negatively affected the ability of the MS to implement additional policies and measures (EC, 2016b).

Among the measures implemented by individual Member States to achieve the objectives of the Effort Sharing Regulation, policies were implemented to incentivise investments to reduce emissions in the diffuse sectors. For example, Germany introduced in 2008 a special fund for energy efficiency in small and medium-sized enterprises, which covers the consultancy and investment costs related to improving energy efficiency in these enterprises; while the Bulgarian government provides loans to banks for them to provide loans to private companies for industrial energy efficiency projects (Gavard & Diethelm, 2022).

However, the costs and benefits of investments in the diffuse sectors are difficult to quantify, as it is complex to establish a direct link between many national climate and energy policies and emission reductions in the diffuse sectors. In addition, the policies and measures reported by the MS do not provide sufficient information on their expected and actual costs and benefits (EC, 2016a). Among the four main sectors covered by the Effort Sharing Decision (transport, buildings, waste and agriculture) the most cost-effective reductions were found in the buildings sector, with measures in the other sectors being more costly. In particular, some measures in the agricultural sector have a very high cost per tonne of CO_2 reduced (EC, 2016b).

Regarding the other policies assessed, instruments like standards have been instrumental to provide certainty for investments over a long-term planning horizon (Kollamthodi et al., 2020). For example the Regulation for on CO_2 emission performance standards for cars and LDVs or the Alternative Fuel Directive. The setting mid and long term targets provides stakeholders with a

clear idea of the requirements to be met which had a positive impact on incentivising further R&D investments. However, as mentioned previously, the ambition of these policies, at least in the initial versions of the policies, was not as high as necessary.

The NER300 Programme has provided interesting lessons in terms of breakthrough innovation. Its funding through a number of allowances has led to a much lower than expected amount (2.1 billion Euros instead of the expected 6 to 9), which limited the funding of the larger and most ambitious projects. Also, the requirement of matching 50% of the granted funds with external investments has also proved challenging. Additionally, no up-front funding has been provided (unless guarantees where obtained from backing Member States), with disbursing being made on a periodical basis upon showing that actual performance was aligned with what was committed in the project. In consequence, some of the funds were left unallocated due to this reason and the beginning of projects heavily delayed by the difficulty in securing these additional funds. According to the EC, the unspent funds amount to EUR 623 million. These funds are reinvested through other existing EU financial instruments managed by the European Investment Bank: InnovFin Energy Demo Projects (EDP) and Connecting Europe Facility (CEF) Debt Instrument.

Another key element related to investment is the role of the financial sector. According to the experts interviewed, the EC has so far done too little to try to align investment flows and climate policy. Actions taken so far have often been more cosmetic than effective. In this regard, although in the 2005-2020 period there was little action on this topic, the importance of finance has since gained momentum.

3.1.2.3 Infrastructure

As mentioned above, carbon pricing through an emissions trading system allows to reduce emissions where it is cheaper. As a result, this type of instrument is not the most prone to stimulate large scale and coordinated infrastructure investments. That is why there is a need of complementary instruments that deal with the long-term planning of infrastructure and the funding support to carry them out. For example, in terms of planning, the Trans-European Networks for Transport and for Energy and, directly linked to the EU ETS, the NER300 Programme (and now the Innovation Fund) provides funding for new projects that require investment in new infrastructure.

However, that is not to say that the EU ETS did not have an impact in infrastructure investments. The capacity of the EU ETS to stimulate such investments is closely linked to the carbon price levels. A clear example can be seen with coal plants. As the price started to increase in the last few years, the incentive to close them down and replace them with lower emission technologies, such as RES, has been higher as seen in practice throughout (Evaluation of the EU ETS Directive - Publications Office of the EU, n.d.). For long term infrastructure investments, a strong and stable price signal is needed.

As per the Effort Sharing Decision, an assessment from an infrastructure point of view is complex. While it is true, as in the case of innovation, that setting emission reduction targets stimulates the implementation of measures that will entail both public and private investments decisions in infrastructure, the generality of the measure does not allow them to be assessed jointly.

Having a public strategy of implementation and investment is a key element to ensure the viability as well as to try to avoid disparities and distributional effects related to the access to services in scarcely populated areas. Thus, specific policies have targeted directly infrastructures. Some of these like the TEN-T for transportation and TEN-E for energy regulate infrastructures with important implications for the environment. In the case of energy interconnectivity and common standards will be increasingly important in the context of the transition to RES.

Additionally, as mentioned above, there have been specific infrastructure policies with climate action in mind. The alternative Fuel Directive is a good example where standards have been set both to ensure possibility of the diffusion of technologies based on alternative fuels and the interoperability among MS.

From an infrastructure perspective the NER300 Programme has played an important role as, for the most part, the technologies to develop in the funded projects require substantial infrastructure. This applies to RES developments and to CCS projects.

However, the most infrastructure-heavy, projects such as the large-scale biofuels demonstrators and CCS projects did not end up being funded under the Programme. There are a few reasons that can be summarised in two main aspects. First, as mentioned above, the lower-than-expected price of allowances from the ETS left a much lower budget which was in many cases not sufficient for this type of projects. Secondly, the design of the calls, which included several conditions to ensure distribution of the funds at geographical and technology levels, and the need to secure private funding, also complicated the development of such projects.

Another aspect to take into account is the fact that infrastructure is not technology neutral (Görlach et. Al., 2022). That is, for example, in the case of energy, the decision to back certain technologies has an influence on the type of infrastructure that will be required to transport and distribute it. Although in this case individual projects were funded in their own merit and not with a perspective of its integration into the grid, the backing of specific projects does affect future infrastructure investment decisions.

3.1.2.4 Integration

Policy integration has been one of the challenges in the EU GHG emissions mitigation policies. To avoid policy uncertainty, it is advisable to integrate and mainstream climate policy priorities at all levels of government (Paltsev, 2019). Although the climate targets set for the 2020 period were clear, the operationalization of these goals through specific policies has resulted in a complex set of instruments were not necessarily designed taking one another into account.

As mentioned above, there is a need to have complementary instruments. That is, more general instruments like the EU ETS and other more specific policies to address sectoral aspects or, also, regulate aspects that were to be implemented at the MS level. However, for these instruments to be effective and efficient, they need to be coordinated in terms of how they contribute to the common goal.

In this regard, the coexistence of an EU ETS and the ESD illustrates that the policy architecture has often been the result of what could be agreed politically and according to the EU allocated competences. The fact that certain sectors were covered by the EU ETS and the rest were left to MS discretion was not a strategic decision with climate goals in mind and has not contributed to a coherent and consistent implementation of policies. The inclusion of new sectors to the EU ETS in the near future as well as the new extension of the EU ETS 2 for buildings and transport could be a step forward into having a more integrated policy. However, even with the new emission markets, the ESR will remain, thus potentially creating an additional layer of complexity.

Some of the interviewed experts have referred to the overlap of instruments and the lack of coherence among them. This risk of overlap has occurred among EU policies but most importantly among the EU and MS policies. For example, in the power generation sector that is covered by the EU ETS, we find numerous instances of other instruments at MS levels like environmental taxes that are targeted to the same sector. Although formally it can be argued that since the instruments target different aspects (emissions vs production for example) there is no overlap. While this might be true, it does not contribute to a coherent climate policy as the instruments coexist but have not been designed in conjunction to achieve a common goal in the most effective and efficient ways. Additional overlap and lack of coordination exists within MS policies at national level.

3.1.3 Related relevant outcomes of GHG reduction policies

Macroeconomic impacts

The empirical literature has carried out simulations of the impacts of introducing or increasing energy taxation, both individually and as part of green tax reform (GTR) packages, using different empirical technologies (macro and micro models), and at different locations and points in time (ex-ante or ex-post). Based on the compilations of this work at the global level carried out by Gago et al. (2014, 2016), we have extracted the results of this literature for the European Union in the period of 1990-2016.

Figure 4 summarises the main macroeconomic impacts of the application of these taxes in the literature. As can be seen in this figure, the impacts on GDP, welfare, employment or CPI are generally small, in the range of ±0.5%. These effects are more favourable when the taxes are part of VRT packages, so that the empirical evidence indicates that recycling the revenues from energy-environmental taxation allows smoothing the possible negative macroeconomic impacts of these taxes. In the case of employment, the results are particularly good if the additional revenue obtained is used to reduce the fiscal costs of labour (social security contributions).

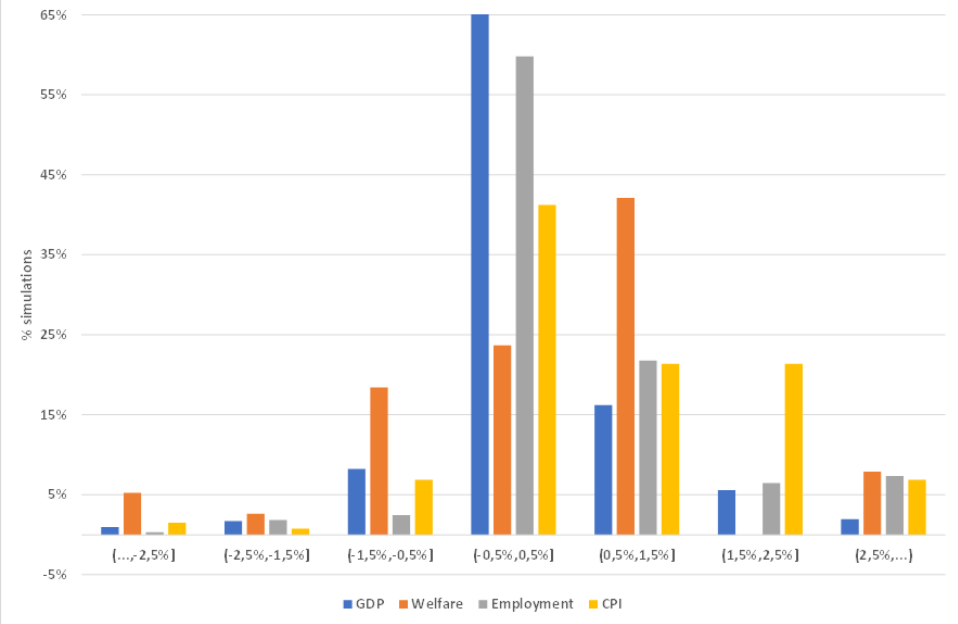

Figure 4. Main macroeconomic effects of energy-environment taxation

Source: Gago et al. (2014, 2016) and authors.

Note: We consider 413 simulations of GDP impacts, 38 simulations of welfare impacts, 326 simulations of employment impacts and 131 simulations of CPI impacts, drawn from 69 articles.

Eurofound (2019) has analysed the potential economic and employment impacts in the EU of a set of policies enabling the transition to a low-carbon economy. Their results show that the impact of these policies has been positive for the EU as a whole. Thus, under a reference scenario, in 2030 climate policies will increase GDP by 1.1% and employment by 0.5%. The positive impact on GDP will derive mainly from additional investments in energy efficiency and renewable electricity generation, as well as reduced dependence on fossil fuel imports, although this will vary significantly across countries. In the case of employment, the impacts will be similar to those on GDP, although smaller in magnitude. Thus, the positive effects on employment will also be the result of increased investment activity and reduced fossil fuel imports, which will boost domestic demand, output and employment. However, the impacts on employment will differ across sectors, with significant reductions in the mining sector and, to a lesser extent, in the utilities sector, and increases in the remaining sectors.

Distributional impacts

One of the risks of environmental taxation, as in other taxes, is the existence the distributional effects when they are regressive. That is when they end up having a stronger impact on lower income households. The distributional impacts of energy-environmental taxation on households depend on their share of expenditure on the taxed products (direct effects), as well as on other products and services whose prices increase when energy prices rise (indirect effects) (Ari et al., 2022). In general, direct effects represent the main source of additional costs, while indirect effects are comparatively small (Steckel et al., 2022). In principle, their impact is regressive, as richer households consume more energy in absolute terms, but the share of energy expenditure

tends to be higher for low-income households (Combet et al., 2010). In addition, poorer households spend relatively more on carbon-intensive goods and services (Marron & Toder, 2014) and are more likely to own older and less energy-efficient durable goods (Zachmann et al., 2018). Thus, results from the collected empirical literature (see previous point) show that 78% of simulations of the distributional impacts of energy-environmental taxation in the EU have a regressive impact.

However, energy consumption varies significantly depending on the geographical location of the household (Carl & Fedor, 2016), so that, in general, rural households are particularly affected (Flues & Thomas, 2015) due to their demand for transport fuels and electricity, a consequence of the lower availability of public transport and alternative energy products. Another important factor is the energy product taxed. In this sense, generally energy-related transport taxes are less regressive than those on electricity or heating fuels (Ekins & Speck, 2011; De Mooij et al., 2012; Flues & Thomas, 2015) because lower income households, on average, spend a smaller share of their income on transport fuels as they are less likely to own a car, so their impact may even be progressive (Rausch et al., 2010; Renner et al., 2018).

Impact on health

The public health co-benefits of climate policies have long been studied (see Karlsson et al., 2021; Gao et al., 2018). Overall, empirical evidence suggests that GHG mitigation strategies in power generation, transport, food and agriculture, households and industry could simultaneously deliver health benefits. For example, GHG mitigation actions aimed at reducing fossil fuel combustion can produce health benefits by reducing local air pollution, because GHGs and air pollutants are largely emitted by the same sources. Such win-win opportunities can make GHG mitigation strategies more attractive and encourage their implementation. At the very least, co-benefits can reduce or even exceed the costs of taking action on climate change and can therefore strengthen the case for mitigation policies (Gao et al., 2018).

In the case of Europe, Schucht et al. (2015) estimate that a climate change mitigation scenario that limits global temperature increase to 2°C by the end of the century would generate significant co-benefits for health, with a 68% reduction in life years lost due to PM2.5 exposure and an 85% reduction in premature deaths due to ozone by 2050, as well as air pollution mitigation cost savings of 77%. These co-benefits would offset at least 85% of the additional cost of climate policy in Europe. Vandenberghe & Albrecht (2018) estimate that a carbon tax of EUR 30-60/tCO_2e could avoid losing between 42300-78800 disability-adjusted life years in Belgium, or save between 0.6-1.1% of total health expenditure.

Impacts on competitiveness

The pollution paradise hypothesis suggests that a unilateral national climate change mitigation policy would impose significant economic costs on carbon-intensive industries, leading to a decline in production and an increase in net imports (Aldy & Pizer, 2015). However, Peterson & Klepper

(2008) show that the impacts of European climate policies on competitiveness are relatively small if fossil fuels, whose consumption is assumed to be reduced anyway, are not considered. Moreover, losses in energy-intensive industries are compensated by gains in other manufacturing sectors, although the impact is not uniform across the US. In any case, impacts on competitiveness depend strongly on the design of climate policy, so that the choice of more efficient instruments not only reduces the effect on competitiveness, but also spreads the burden more evenly.

In this context, given the magnitude of the competitiveness impacts of climate policy, the potential economic and diplomatic costs of policies to protect the competitiveness of domestic companies may outweigh the benefits and justify no action at all (Aldy & Pizer, 2015).

In the case of the EU, the EU ETS increases the price of energy inputs, which may create a disadvantage for production in the EU relative to production in other jurisdictions without a carbon price. This may reduce the effectiveness of climate policy due to carbon leakage, by shifting production and emissions to other jurisdictions. In the EU ETS, the main mechanism to mitigate the risk of carbon leakage has been the free allocation of allowances to certain industries and sectors at higher risk of carbon leakage, due to their energy intensity or exposure to international trade. However, this measure reduces incentives to reduce emissions (Benson et al., 2023). Therefore, the EC (2021), within the "Fit for 55" package, proposed the introduction of a border carbon adjustment mechanism. This mechanism is an import tariff on carbon-intensive goods, functioning as an import tax paid by the importer when the product enters the EU, specifically through the purchase of certificates representing the emissions embodied in the products. The cost of these certificates will be based on the price of carbon in the EU-ETS, thereby reducing the risk of carbon leakage by incentivising producers in non-EU countries to green their production processes. In December 2022, the Council of the European Union and the European Parliament reached an agreement on the implementation of this mechanism (EC, 2022), with a transitional period starting in 2023 and an entry into force in 2026.

3.1.4 Concluding observations on the qualitative assessment of the EU climate policies from the perspective of the 20% reduction of GHG emissions

It has already been pointed out that the goal of achieving a 20% reduction in GHG emissions compared to 1990 levels has been achieved. However, it has also been addressed that part of this reduction has been due to external factors beyond EU policy. Nonetheless, the EU climate policy has had a substantial impact and it cannot be denied that the current policy framework resulting from the experience and work of the past 20 years much more developed and oriented to have a chance at meeting the neutrality goals set for 2050.

The assessment of the selected policies, the analysis from the 4i perspective and the inputs provided by the experts interviewed allow us to draw some main conclusions.

One of the main issues that seems to be quite consensual is the importance of the institutional framework and decision-making procedures in the EU in the design of the specific policies and instruments. The clearest example is the decision to establish an emissions trading system over the initially preferred option by the EC of a carbon tax (Alice Pirlot, 2020). Thus, the final policies implemented did not necessarily reflect the views of the EC but the common denominator among the EU institutions and the MS.

A second aspect, quite related to the first, is the debate on whether EU climate policies in the assessed period have been ambitious enough. Here there seems to be diverging opinions both among academics and among practitioners. On the one hand, some argue that a step-by-step approach, like the one that has been implemented, was the right way to proceed in order to be able to achieve the necessary consensus to effectively introduce and implement decarbonization policies. However, some of the experts interviewed and part of the academic literature is quite critical with this idea (Lilliestam et al., 2021). According to the alternative vision, there has been a lack of ambition that has led to missing important opportunities to act sooner and avoid harder decisions that will need to be taken in order to achieve climate neutrality by 2050.

This debate is directly linked with the third point which relates to acceptability. According to the more gradual perspective, the more ambitious policies that are currently being implemented have only been possible because a progressive approach has been taken which made more palatable to both public and private stakeholders trying to resist these policies. The argument is not only based on this point, but also in the learning process that the first phases of these policies have entailed. In this sense, according to (Paltsev, 2019) in many cases, pilot programmes can help fine-tune policy design and prepare economic agents for policy compliance. The learning process not only from pilot phases but form the successive phases is quite apparent in the EU ETS, the NER 300 Programme and the rest of policies that have eventually been updated to correct some of the shortcomings both relating to ambition and instrument design and implementation.

The acceptability of policies has also been important at MS and citizen levels. Although some MS have been more reluctant to accept certain targets and policies, experts consider that, as a result of the EU common approach and ambition, these MS have ended up implementing stronger climate mitigation measure that they would have otherwise. In terms of citizens, the collective work at the EU level also seems to have been an important resource for MS to justify and gain acceptability for some more unpopular measures.

A common criticism has been the different levels of ambition regarding different sectors. Most experts have highlighted the underwhelming results in terms of regulation of the transportation and agriculture sectors. In this regard it is considered that the Commission and MS have preferred to act in sectors where there was less resistance thus leaving behind these two sectors with a very important share of emissions. Some of the experts interviewed have stated that even with the EU ETS2 integrating road transport emissions, this is still not enough and probably not the most efficient measure for the sector. In terms of agriculture, experts highlight the inconsistency

of keeping some subsidies to fossil fuels with the general goal of advancing towards decarbonisation.

Another recurring issue during the interviews has been whether the share of the decarbonisation burden has been distributed fairly and in an equitable way among MS. Some of the interviewees argue that eastern and central Europe states have needed to take larger action as they started from less advanced positions. Also, there has been some criticism regarding treating all eastern and central Europe states as one group without taking into account different realities and needs in terms of implementing climate policies.

Finally, the role of the Paris Agreement has been praised in interviews and also highlighted by the academic literature as playing an instrumental role in creating the momentum to achieve consensus to raise the ambitions and triggering the reach of more ambitious climate policy goals that led to the review of some of the policies to update them to the new more stringent requirements.

3.2 Target: to achieve a share of 20% RES in final energy consumption in 2020

3.2.1 Assessment of the design and implementation of the policy mix to achieve a share of 20% RES in final energy use in 2020

Given the climate emergency and the resultant international obligation, the EU has to reduce GHG emission. The EU and its Member States (MS) have designed and implemented several policy measures to achieve a 20% share of renewable energy in final energy consumption by 2020. This section provides a qualitative assessment of these policies between 2005 and 2020.

As outlined in the 2007 Communication from the European Commission to the European Council and the European Parliament (Energy Policy for Europe, 2007), energy accounted for 80% of the greenhouse gas emissions in the EU and was at the root of climate change and most of air pollution. At that time, the energy and transport policies were projected to cause a 5% increase in CO_2 emissions by 2030.

One of the three targets set by the European Union in its March 2007 conclusions was to achieve a 20% share of energy from renewable sources in final energy consumption in 2020, as well as a 10% target for biofuels in the transport sector. This was a continuation of ongoing efforts – the European Union started working towards a target of a 12% share of renewable energy in 1997 in its overall mix by 2010, a doubling of 1997 levels, however that plan did not succeed. The 2007 targets and plans drew from those experiences. As recorded in the conclusions, the Council of the European Union pointed to general measures to achieve these objectives:

1. Establishing a legal framework for the development of renewable energy sources, with a new comprehensive directive on the use of all energy resources from renewable sources at its core;
2. Analysis of the opportunities arising from the further integration of European markets, cross-border synergies and interconnections;
3. Cooperation with Member States on the development of renewable energy development.

Importantly, the Council of the European Union seemed to be aware (Council of the European Union, 2007) of the importance of creating the right conditions for development and economies of scale to make RES economically viable, which at the time were expensive and maturing technologies that required appropriate support. These elements were emphasised in the 2007 Council of the European Union conclusions.

The increasing and excessive dependence on imported hydrocarbons was seen as the second reason behind setting a target for renewable energy use in the EU. Reliance on imports of gas was expected to increase from 57% to 84% by 2030, and of oil from 82% to 93%. Overall, dependence on energy imports has been steadily increasing and has risen from 50% to 58% since the early 1990s. Boosting the competitiveness of the EU and reducing the impact of price volatility and price rises on international energy markets were seen as another objective of setting a target for renewable energy use. The import bills Europe paid for oil hydrocarbons did not create additional jobs in the EU and resulted in a wealth transfer to countries with questionable record on human rights.

On the basis of the mandate given by the Council, the European Commission prepared a legislative package (2020 climate and energy package) aimed, inter alia, at introducing measures to meet this objective. Subsequently, the European Commission also produced a Communication, Energy 2020 strategy for competitive, sustainable and secure energy (COM/2010/0639), which further set out how these objectives were to be achieved.

Within this analysis we have predominantly focused on the following legislation and documents and their developments during the period of 2005-2020:

- Renewable Energy Directive (Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the Promotion of the Use of Energy from Renewable Sources and Amending and Subsequently Repealing Directives 2001/77/EC and 2003/30/EC (Text with EEA Relevance), 2009) and its revision RED II (Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the Promotion of the Use of Energy from Renewable Sources (Recast) (Text with EEA Relevance), 2018)
- EU ETS Directive (Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 Establishing a Scheme for Greenhouse Gas Emission Allowance Trading within the Community and Amending Council Directive 96/61/EC (Text with EEA Relevance), 2003) and its further revisions (Directive 2008/101/EC of the European

Parliament and of the Council of 19 November 2008 Amending Directive 2003/87/EC so as to Include Aviation Activities in the Scheme for Greenhouse Gas Emission Allowance Trading within the Community (Text with EEA Relevance), 2008), (Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 Amending Directive 2003/87/EC so as to Improve and Extend the Greenhouse Gas Emission Allowance Trading Scheme of the Community (Text with EEA Relevance), 2009)

- Alternative Fuel Infrastructure Directive (Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the Deployment of Alternative Fuels Infrastructure (Text with EEA Relevance), 2014)

We also mention other legislation and documents that influenced the development of renewables during this period (and conversely, the pace of development and non-regulatory factors influenced what subsequent legislation looked like). In addition, the climate policy of the European Union gained considerable momentum in the last few years of the period under review.

The European target was established to achieve a 20% share of renewable energy in final energy consumption by 2020. Individual Member States could, however, set out "national targets for the share of energy from renewable sources consumed in transport, electricity and heating and cooling in 2020". The Member States were obliged to adopt their own national renewable energy action plans (Directive 2009/28/CE, Article 4) and national targets ranged from 10% to 49%. This discrepancy resulted from the fact that at the time (in 2010) the energy mixes of EU countries varied significantly, as well as their geographic, economic and social background, and so did their individual ambitions – depending, among others, on the political will of the government regarding the development of RES. Moreover, because EU climate policy was much less ambitious then than it is now, without the external pressure Member States differed significantly in how they approached energy transition-related objectives. For instance, Austria (62,9%) and Sweden (50.9%) already produced more than half of their electricity from renewables, while countries such as Estonia, Lithuania, and Poland were almost fully reliant on fossil fuels. The Table 3 below displays the progress in increasing the share of RES between 2005 and 2020 in EU Member States.

Table 3. Share of energy from renewable sources in gross electricity consumption, 2005-2020

	2005	2010	2015	2020
EU	16.4	21.3	29.7	37.4
Belgium	2.4	7.3	15.6	25.1
Bulgaria	8.7	12.4	19.0	23.6
Czechia	3.8	7.5	14.1	14.8
Denmark	24.6	32.7	51.3	65.3
Germany	10.6	18.2	30.9	44.2
Estonia	1.1	10.3	16.2	28.3

	2005	2010	2015	2020
Ireland	7.2	15.6	25.7	39.1
Greece	8.2	12.3	22.1	35.9
Spain	19.2	29.7	37.0	42.9
France	13.7	14.8	18.8	24.8
Croatia	35.2	37.5	45.4	53.8
Italy	16.3	20.1	33.5	38.1
Cyprus	0.0	1.4	8.4	12.0
Latvia	43.0	42.1	52.2	53.4
Lithuania	3.8	7.4	15.5	20.2
Luxembourg	3.2	3.8	6.2	13.9
Hungary	4.4	7.1	7.3	11.9
Malta	0.0	0.0	4.3	9.5
Netherlands	6.3	9.6	11.0	26.4
Austria	62.9	66.4	71.5	78.2
Poland	2.5	6.5	13.4	16.2
Portugal	27.7	40.6	52.6	58.0
Romania	28.8	30.4	43.2	43.4
Slovenia	28.7	32.2	32.7	35.1
Slovakia	15.7	17.8	22.7	23.1
Finland	26.9	27.2	32.2	39.6
Sweden	50.9	55.8	65.7	74.5

Source: Eurostat

Under the EU Directive 2009/28/EC, EU member countries were obliged to submit National Renewable Action Plans (NREAPs) to the European Commission by June 2010 outlining pathways that will allow them to meet their 2020 renewable energy targets. These were individually prepared by each country and contained policies and measures that were intended to help achieve national objectives, which are part of governance at the EU level. The plans had to contain sectoral targets, the expected technology mix used to achieve the goal, the trajectory of proposed changes, as well as the measures and reforms the countries would undertake to overcome the barriers to developing renewable energy. The plans were evaluated by the European Commission and assessed in terms of completeness and credibility.

The RED I Directive was revised in 2018 and replaced by the Directive (EU) 2018/2001 (RED II), which establishes a common framework for promoting energy from renewable sources in the EU and set a binding overall target of 32% of the EU's gross final consumption of energy to come

from renewable sources by 2030 (already revised by later legislation). It has also set a sustainability and greenhouse gas emission saving criteria for biofuels, bioliquids and biofuels for transport. It also laid down rules on financial support to promote the use of renewable energy sources.

The EU ETS has been a critical tool in the effort to reduce greenhouse gas emissions, a cornerstone of EU climate policy. As a cap-and-trade system, its primary objective is to incentivise producers in affected industries to reduce their GHG emissions by putting a price on them. Consequently, it contributes to making fossil fuels less cost-competitive and, implication, to making renewable energy sources more cost-competitive. The funds available to Member States under the EU ETS in the period 2005-2020 had significant potential to support the development and competitiveness of RES, as MS were required to designate at least 50% (or equivalent) of the auction revenues for energy transition-related projects. Lower-income Member States were also eligible for derogation under Article 10c, according to which they could benefit from free allocation for electricity producers, as long as it was designated for retrofitting and upgrading of the infrastructure and clean technologies. However, the funds under the EU ETS were ultimately used differently by different countries, with varying levels of support for the energy transition, as Member States could, among other factors, choose from a broad catalogue of activities to which the funds could be devoted. Therefore, the EU ETS at the time served the purpose of redirecting financing toward low-carbon innovation and the modernization of the energy sector, albeit to a limited extent (Andrei Marcu et al., 2020).

Apart from the general target for renewable energy usage, the first Renewable Energy Directive (RED I) promoted the use of biofuels and other alternative fuels by setting a 10% national target for the use of renewable energy in the transport sector. RED I was not the only legislation pushing the norms for transport usage of renewables: Fuel Quality Directive (FQD) set a carbon intensity reduction target of 6% on each fuel supplier in 2020 (Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 Amending Directive 98/70/EC as Regards the Specification of Petrol, Diesel and Gas-Oil and Introducing a Mechanism to Monitor and Reduce Greenhouse Gas Emissions and Amending Council Directive 1999/32/EC as Regards the Specification of Fuel Used by Inland Waterway Vessels and Repealing Directive 93/12/EEC (Text with EEA Relevance), 2009).

While RED has set a market share target of 10% of renewables in transport fuels, electricity, hydrogen, biofuels, natural gas and liquefied petroleum gas (LPG) have been identified as the main alternative fuels that currently have the potential to replace oil in the long term, as reflected in the Communication from the Commission of 24 January 2013 entitled 'Clean Power for Transport: A European alternative fuels strategy'.

The lack of a clear requirement for the use of advanced biofuels and renewable electricity meant that the renewable energy target for 2020 in transport was achieved mainly by methods with questionable impact on the environment. Due to lack of available arable land in the EU fulfilling the need for biofuels required outsourcing of the production to the global South. The production

of biofuels created major sustainability gaps and has driven the use of crop based biofuels, such as palm oil, soy and rapeseed. This has initially led to deforestation and unsustainable land use practices.

As the negative impacts of biofuel usage became evident, the EU policy on this subject changed with the implementation of measures set to combat Indirect Land Use Change. The U-turn on biofuel usage was seen in the 2018 recast of Renewable Energy Directive (RED II) including an amendment of crop biofuel allowances to 3.8%. Further EU policy focused on the support for advanced biofuels and renewable electricity.

The overall 10% goal was eventually met in 2020. The share increased from 1.6% in 2004 to 10.2% in 2022, slightly exceeding the expected target. Sweden was the clear leader in the use of renewable energy transport with 31.9% share followed by another Nordic country, Finland (13.4%) and The Netherlands and Luxembourg (12.6% for both countries). Greece (5.3%) and Lithuania (5.5%) registered the lowest share.

While EU has made significant progress towards promoting the use of renewables in transport, during the period of 2005-2020 fossil fuels were still subsidised massively. Between 2013 and 2015 the overall subsidies for petroleum have actually increased (European Parliament 2017). In 2013 they were as high as $3,137 per capita in Luxembourg, $678 in Denmark and $432 in Belgium.

Despite the potential benefits that could result from the removal of fossil fuel subsidies, governments were often reluctant to undertake the necessary reforms and no clear goals were set by the EU policy in that regard.

An important element influencing the development of RES is the creation of appropriate, secure conditions for investment. A competitive, harmonised energy market was supposed to provide such an environment by ensuring greater transparency and generating price signals.

In 2009, the European Parliament and the Council of the European Union adopted the so-called Third Energy Package, which included two market directives and the transmission regulations (regulations for electricity and gas, respectively), as well as a regulation establishing the Agency for the Cooperation of Energy Regulators (ACER). The main objective of the third package was to create a fully effective and single European electricity and gas market that would ensure an uninterrupted supply of electricity to all EU consumers, meeting environmental standards and priced transparently. This is to be achieved by harmonising the powers of national regulators, harmonising the tasks of transmission system operators while ensuring their independence, common rules for the operation and development of the network, and by strengthening the rights of energy consumers. European institutions have been set up for cooperation between regulators (ACER) and operators (ENTSO-E) were established. Additional, regulatory tools were established to limit antimarket behaviour of companies and increase the level of competition.

In 2019, another directive of common rules for the internal market for electricity was introduced. It was a response to the changing needs of the electricity system and the need to include new products and services.

In the period analysed, the EU's climate and energy policy relied predominantly on setting goals and constructing policy frameworks that would guide Member States in their implementation of national policies, in accordance with their country-specific needs and priorities. To do that, the EU introduced several governance instruments under, among others: the Renewable Energy Directive, the Energy Efficiency Directive, and the Effort Sharing Decision. Examples of governance tools included the obligation to submit a National Renewable Energy Action Plan (RED I) or to prepare a national energy efficiency plan every three years (EED). Despite the emerging Energy Union Strategy, aimed at coordinating and integrating energy policies across the EU, at the time, Member States maintained a relatively high degree of sovereignty over national policy. However, the EU put in place a system of reporting on national progress and other monitoring measures, such as reviews of Member States' greenhouse gas inventories (ESD) or the obligation for countries to report on renewable energy development every two years (RED I). Another overarching objective was to create a liberalised internal energy market, designed to facilitate (or at the minimum, not hinder) the development of RES. The instrument that differs significantly from the other tools introduced in the period is the EU ETS due to its EU-wide character and resilient, independent of Member States design (namely, EU-wide caps on emissions). Still, some EU ETS-related decisions remain under the competences of Member States, e.g., the use of auction pool revenues.

However, the existing regulatory framework and other factors that we discuss later in this chapter allowed the achievement of 2020 renewable energy targets. The final figures reported by the EU countries in 2022 indicate the achievement of a 22.1% share of renewable energy in gross final energy consumption in 2020, exceeding the 20% target set by the 2009 Renewable Energy Directive. A study by Papież et al. (2018) shows while all EU countries increased their share of RES in the energy mix, the increase was uneven. The share of each RES technology in total RES in each country also varies significantly. The paper also lists energy security, environmental concerns, economy and politics as potential determinants of renewable energy development. The authors also stated that GDP per capita, energy supply concentration, and energy consumption cost were factors influencing and stimulating renewable energy development.

Fig. 6 depicts the evolution of RES targets set out in the Renewable Energy Directive (2009/28/EC), its 2018 recast and other follow-up actions like the REPowerEU Plan (which is beyond the analysis period). It shows the exact overrun of the 20% target defined in 2009 and its lack of ambition compared to later policy updates (32% in the recast Directive and 45% in the REPowerEU Plan). The more ambitious approach set by the 2021-2022 proposals is a sign of acceleration in the EU clean energy policies and the political will to divert from the dependency on fossil fuels. The 2021-2023 energy crisis confirmed the validity of the initial assumptions behind the shift towards renewable energy: overdependence on external sources proved to be dangerous for the competitiveness and stability of the EU economies.

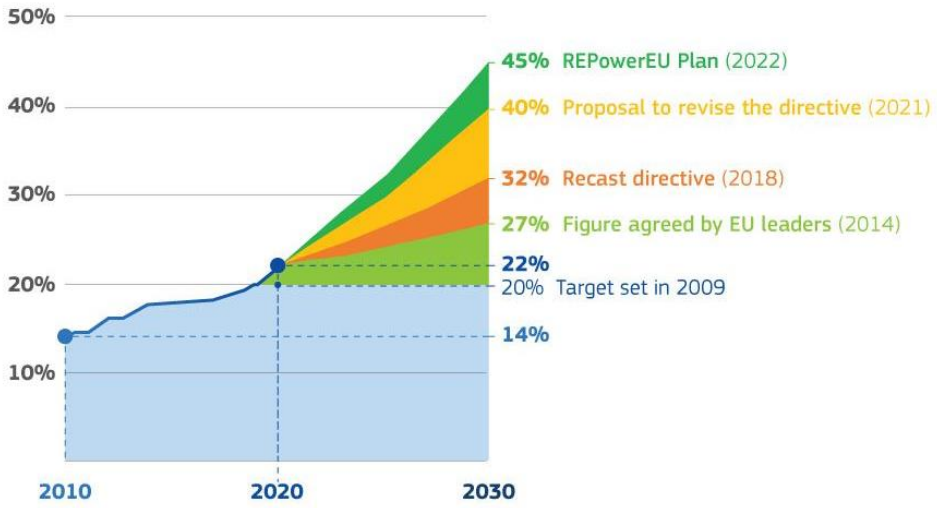

Figure 5. Evolution of renewable energy targets

Source: European Commission. Renewable Energy Targets.

In the following section, we describe more detailed developments and factors that have influenced the development of RES in the context of the 4i's: innovation, investment, infrastructure and integration.

3.2.2 Main insights from the 4i perspective

3.2.2.1 Innovation

Research, innovation and competitiveness is one of the five closely linked and mutually reinforcing areas of the Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy (2015). Therefore, innovation policy is an area to which future economic development hopes have been linked in each successive period of development programming of the European Union. Its flagship area within research and development has been the successive Framework Programmes (later the Horizon Programmes), which have been a kind of umbrella for research and development activities. In their wide range of research activities, they have also included the development of RES.

In contrast to the current Horizon Europe Programme, in which missions like 100 Climate Neutral and Smart Cities by 2030 are included in previous framework programmes (H2020 and previous), this type of approach did not exist. In fact, they were the umbrella under which many innovative projects were funded, but there was no direct link between climate policy in terms of RES and innovation policy, including R&D activities. In other words, there was no direct connection between the goal of achieving a 20% share of RES in final energy use in 2020, and the scope of actions the called within the R&D programmes. The missions could have been implemented much earlier, linking the climate policy for renewable energy with technological development and organisational and social innovations that could have been produced by international research

teams working on European projects. This would involve identifying the sectors that need the most innovation (e.g. steel, cement, large chemicals) in terms of the need for renewable energy. Then use the innovation resources that you have and fund the projects that will help you get there. And this is a different way of spending innovation funds than was the case between 2005 and 2020. Acting this way would have helped to achieve even better results than actually achieved, or to achieve a comparable result, but with less effort.

During the period under review, it was difficult to expect a coherent innovation policy in a situation where 10 new Member States joined the EU in 2004, with different characteristics, resources, and mentalities from western and northern Europe. These countries were technologically backward compared to the so-called "old Europe" and found it difficult to cooperate on an equal footing. At that time, the efforts of these countries were focused on the structural funds, which aimed to equalise their living standards with those already in the EU. As a result, innovation policy received less attention and insufficient resources. In the social sphere, there was also the problem of mass emigration from Central and Eastern Europe, which included not only blue-collar workers but also highly skilled white-collar workers. There was also a pre-1990 perception in these countries that multiannual objectives and programmes were never fully implemented, with the result that ambitious provisions in strategic documents, including in the area of renewable energy sources, were not taken seriously enough. In Poland, for example, the dominant strategy was to pretend to take action and wait for the problem to improve before changing policy. In recent years, this attitude has been changing in a favourable direction and its intensity has been decreasing, although this process is still ongoing and should be taken into account in future actions for some time to come. The latter, together with the lower level of universities and R&D centres and the weakness of the private sector in terms of resources for innovative research, continues to result in an unequal distribution of resources and levels of expenditure between the countries of Western and Southern Europe and the CEE or Southern European countries.

As Steen et al. (2019) points out, it was possible to foster renewable energy with smart specialisation. What is new about RES III compared to previous EU innovation policies is that it aims to develop regional competitiveness based on the exploitation of regional assets, rather than focusing on the provision of innovation infrastructure. They show that energy-related priorities are based on a broad understanding of innovation. For example, some regions aim to upgrade and modernise existing sectors or support diversification into new energy-related business and market activities, while others target niche segments of the energy system and related value chain.

The situation was not improved by the not so good situation of grant makers at the national level and their rather moderate, conservative approach to the topic of renewable energy sources. As demonstrated by Papież et al. (2018). Member States without their own fossil fuel sources have been developing RES to the greatest extent. These countries were the most supportive of renewables. Some exceptions were also that they started to unbundle coal assets earlier, allowing investment in renewables.

It has been a failure of innovation policy in relation to the development of RES that European industry has not been protected from competition from, for example, Asian countries. The issue of Chinese investments in EU renewable energy sector is discussed by Curran et al. (2017). On the one hand, European and national funds were spent on technological development within innovation activities, while on the other hand no measures were taken to protect the interests of these solutions from overseas competition. A certain conservatism in the approach to RES from an innovation policy point of view was also expressed by the respondents in the qualitative in-depth interviews. They suggested that a more ambitious approach to the issue could have been taken.

Compared to conventional power generation based on large generators with a unidirectional transmission network and a large number of consumers, RES is a revolution. It required the development of new business models and the development of social innovation. Perhaps the issue of innovation in transmission technologies related to RES should have been addressed earlier and the coordination of solutions should have been addressed using a system approach. A similar issue was the steering of the electrical network.

From an innovation perspective, it would have been possible to focus not only on technological and business model innovations as sources of solutions for climate neutrality but also on policy and governance innovations for new concepts like Virtual Power Plant. Decentralisation of the energy market could have been pursued earlier and renewable energy communities could have been supported earlier.

Several benefits could also be achieved by supporting classic innovation activities in the EU regions associated with hard coal and lignite mining with investment activities that support the quality of life in these areas after the end of exploitation. This would reduce the social resistance of the inhabitants of these regions, who have often been associated with this industry for generations and often cannot imagine their lives "post-coal". It would avoid some of the problems of transformation of post-coal regions if the new R&D and production centres and the resulting industry were located at least in part in areas previously involved in fossil fuel extraction and fossil fuel-based energy production.

3.2.2.2 Investment

Investments in RES were determined by a range of factors, including regulatory frameworks, political will, technologies, and energy demand (Sisodia & Soares, 2015).

The EU policy has significantly impacted the desirability of investment in RES by increasing the relative competitiveness compared to fossil fuels (ETS), subsidies on technology development, investment and market design. The Commission has played an active role in removing barriers to RES investment by identifying legislative barriers during the implementation of NREAPs and guiding the Member States on simplification of administrative procedures for renewable energy producers. The Renewable Energy Directive obliged the Member States to simplify procedures,

increase transparency, and ensure coordination of procedures for new renewable energy producers in order to facilitate market access for new entrants, in particular, SMEs.

Over the course of the analysed period, global weighted-average LCOE for renewables significantly decreased, especially solar PV and wind installations. Between 2010 and 2020, it declined by 54% for onshore wind, 48% for offshore wind, and a staggering 85% for utility-scale PV plants (Report on the Achievement of the 2020 Renewable Energy Targets, 2022). The EU's regulatory framework was aimed at achieving the set targets, but the support measures that were introduced at the time also had the purpose of making RES more competitive. Recent analyses consistently demonstrate that RES have become more competitive than fossil fuels. According to a report by IRENA, in 2021 around 73% of newly installed renewable power generation capacity had a lower cost (LCOE) than the cheapest fossil fuel-fired power generation option in the G20 (IRENA, 2022). Although solar PV and wind costs have been on an increasing trend since 2021, their competitiveness has continued to improve due to considerably sharper increases in coal and natural gas prices (IEA, 2022). As IRENA points out, the decline in the price of renewables has been driven by improving technologies, economies of scale, competitive supply chains and improving developer experience (IRENA, 2021).

The scale of RES subsidies has had a major macroeconomic impact on EU economies, reaching EUR 81 billion in 2020 (Enerdata, 2022) creating meaningful employment and transforming the economic systems. By 2018, there were 1,235,000 renewable energy jobs created in the EU (IRENA, 2022)

Other EU-based studies confirm the positive influence of investments in renewable energy on employment. In an analysis of the German renewable support policy, Hillebrand et al. (2006) conclude that the policy is likely to result in a positive level of net employment in the short term but a negative level impact in the medium to long term.

The literature outlines the three main impacts of renewable energy support schemes: direct, indirect (substitution and income effect) and trade effect (Bali Swain et al., 2022). The direct (gross) effect measures a change in job creation in renewable sectors, but does not take into account the substitution and income effects that may be negative in other sectors. A reallocation of the budget to renewable energy may lead to a reduction in employment opportunities in other sectors.

Papers on the effects of renewable energy support policies during the analysed timeframe indicate net positive effects of renewable support policies; however, they indicate a long-term negative unemployment impact. Lehr et al. (2011) suggested that the number of indirect jobs is usually larger than the direct jobs for all renewable energy technologies.

The public health benefit of investments in renewable energy should also be mentioned. During the period of 2006-2018, investment in renewables contributed towards an increase in potential LE of 12 months (Rodriguez-Alvarez, 2021).

The availability of technology, the possibility of its implementation and economic viability played a vital role in the process of development of renewable energy sources. It must be noted that in Europe, major focus was put on the development of photovoltaic and wind farms due to perceived versatility and potential of these technologies. Even though initially regions with significantly higher wind speed or solar irradiance had relative advantage in RES deployment (as the unit cost of energy decreased due to the higher capacity factor), throughout the period the LCOE was steadily decreasing and the cost advantage of those places started to diminish. On the other hand, regenerative energy geothermal plants based on ambient energy, tides, waves and other ocean energy or hydropower or biomass-based solutions are more closely linked with specific geographical or geological conditions. For instance, due to country-specific natural resources, several countries with high potential for hydropower (Sweden, Norway, or Austria) developed a significant share of their capacity in their energy mixes.

In the case of transport, development was based on biofuels and electrification. The development of renewable energy in buildings was focused on the development of heat pump technology using ambient heat.

Moreover, the competitive advantage of wind and solar in the context of opening up the generation market to new types of investors needs to be emphasised. Due to the modular nature, simplicity, and preferability, renewable energy sources became more available to a wider range of actors and investments could be scaled up or down and tailored relative to the capital held and needs. Due to technological, social, environmental and regulatory factors such advancement was not possible for other low-emission sources such as nuclear, hydropower or biomass.

The public support established on the national level was an important factor in influencing investment and development in renewables technologies. Direct support mechanisms included feed-in tariffs, feed-in premiums, investment and financial incentives such as loans at below-market rates. Reuter et al. (2012) set out the following public incentives for companies to invest in renewable technologies feed-in tariffs, investment subsidies, tax credits, portfolio requirements, and certificate systems.

The investment support ecosystem varied vastly among EU countries, however, as noted by Poullikkas et al. (2012) feed-in tariffs were the most popular choice of the policymakers followed by investment support and fiscal and financial measures.

It should be also noted that the choice of support mechanisms must be appropriately matched to the target group of investors or the desired type of investment. The impact of support mechanisms on the development of RES is well illustrated by the example of Germany. For several years, the EEG guaranteed a fixed feed-in tariff (FIT) or variable feed-in premium (FIP), which ensured stable investment conditions for cooperatives and private limited companies based on a relatively low-risk and replicable business model. Since 2017, investment conditions have changed (obligation to sell electricity on the exchange, replacing the fixed tariff mechanism with auctioning). This has resulted in a change in the profile of the investors, with the participants in

the auctions from now on being mainly larger investors developing wind farms (Deutsche Energie-Agentur, 2022).

As the experts surveyed during the project pointed out, the role of the financial sector has been largely overlooked, left on the side-lines. This has impacted the scale of investments carried out in the renewable energy sector. As the scale of investment expenditure in the context of EU climate policy is beyond the capacity of the public sector, there was a need for a redirection of private capital towards more sustainable investments. This will require a profound change in the way in which the financial system operates, because up to this point, banks and financial institutions have made decisions solely on their own economic interests, without taking into account the interests of sustainable development and climate policy. The argument about long-term risks was often not very relevant in relation to the short-term revenues and profits. The situation has been changing over time, with increasing political and social pressure to move towards climate neutrality in the European Union.

There was a feeling among those interviewed that the EU could do much more to regulate the financial sector, not even through the prism of risk, but through direct investment in certain sectors. This would be much more effective and necessary to channel these financial flows properly, which is not the case at the moment.

EU policy could have been much stronger in preventing investment in the wrong sectors (including fossil fuels). This is a major challenge, and taxation was one way of addressing it. There was no integration of solutions at the EU level; each country had its own solutions.

It was not until 2020 (i.e., not during the period under review) that a system for a single classification of sustainable development measures was adopted. The aim of the EU taxonomy is, inter alia, to provide clarity and a common understanding of what actions can be considered sustainable. It aims to help investors, including entrepreneurs, make informed investment decisions towards more sustainable economies. Not all decisions by financial, corporate, or private investors are equally important when it comes to energy investment (Wüstenhagen and Menichetti, 2012).

In addition, EU countries should have paid more attention to investing in research and development to support the plan for long-term progress in sustainable energy sources for viable energy and economic development (Adedoyin et al., 2020). They found that R&D is bidirectional for renewables and unidirectional for non-renewable. In other words, renewable energy leads to economic growth as the economy grows through the use of renewable energy. The proof of this can be seen in the fact that the export of renewable energy solutions from European countries to other countries as a result of GDP expenditure on research and development for the further innovation of renewable energy solutions will stimulate economic growth. Measures are needed to encourage engineers to develop technological approaches to create renewable technologies.

A separate theme relates to the investment uncertainty associated with the speculative nature of CO_2 allowances. This meant that they did not just serve the interests of issuers but created rate

of return risk associated with RES investments. Was this risk necessary? The experts surveyed were positive about the EU ETS mechanism itself. Companies will invest in low-carbon technologies if these investments are cheaper than the purchase of emission allowance on the market. The market price of allowances under the EU ETS must therefore be set at a sufficiently high level to justify decisions to invest in low carbon technologies. Meanwhile, prices in the period 2011-2017 remained low below EUR 10/Mg, which did not support the profitability of RES investments. However, from 2018 onwards, price increases and volatility became very dynamic, which accelerated the development of RES, but was also considered as increased investment risk. They even pointed to the possibility of increasing its ambition, which could pose significant economic problems for countries with a high share of non-renewable, conventional energy sources in their energy mixes.

In the case of energy market regulation, as indicated in the (European Commission, 2016), electricity market design from 2005 to 2020, especially short-term markets, did not give sufficient continued investments in renewable energy generation will be needed, but regulations during the period of 2005-2020 "did not provide sufficient incentives to stimulate private investment in new generation capacity or networks". Furthermore, wholesale price volatility and overcapacity are not conducive to investment in new capacity and networks (European Court of Auditors, 2017)

An important instrument that can encourage private capital to engage in RES development is cPPAs. However, their design is extremely complex, and the implementation of such agreements is exposed to many risks. In addition, some varieties of cPPAs have been regulated under MIFID II, which has created an additional barrier to their use (KMPG, 2017).

3.2.2.3 Infrastructure

Infrastructure plays a key role in the development of RES. Its development has been observed over the period considered but has been uneven in terms of geography, financing modalities and sources, and regulation. The aim of this part of the analysis is to consider, ex post, whether there could have been a better managed deployment of clean electricity generation infrastructure that is dispatchable, resilient, cost-effective, and socially acceptable. This is essential to support a compatible transition to a low-carbon future to combat climate change (Beriro et al., 2022).

Reaching the goal of 10% renewable energy in transport following the limitation of biofuel usage required rapid deployment of EV charging stations. The Directive on the deployment of alternative fuels (2014/94/EU) infrastructure provided the framework for the development of recharging points. The document "Infrastructure for renewable energies: a factor of local and regional development" explores the possibilities of developing infrastructure for renewable energy sources to meet the objectives of the Europe 2020 strategy. As well as the impact of these investments on the socioeconomic development of the regions. In light of this document and subsequent developments, three key issues can be defined with regard to renewable energy markets and their infrastructure:

- The energy needs of the EU and its people and businesses could not be met by the ageing and investment and maintenance intensive traditional energy infrastructure.
- There were concerns about a possible temporary shortage of fossil fuel energy supplies, which could threaten the EU's energy security, since most of the world's sources and reserves were located outside the EU. There was a clear geopolitical and international political context for such threats. Such threats were very serious given the vulnerability of the network to disruption.
- Peak energy demand and related security issues become an issue in times of increasingly extreme weather events, resulting in increased energy supply needs.

Much attention has been paid to expanding international energy trade, with an emphasis on cross-border joint ventures between neighbouring countries and greater trans-European energy infrastructure. The problem has been exacerbated by the fact that the existing energy infrastructure has not always been sufficient to interconnect and serve the whole of the EU, as well as local renewable energy sources (there have been times when operators have refused en masse to connect more solar farms to the grid).

A further challenge was the fact that the output of many renewable energy sources varies according to the weather conditions. For this reason, a well-configured energy infrastructure could prevent future crises by increasing and changing the mix and dynamics of the supply, which could be easily transported through the European energy grid.

Kramer & Poljan (2012) indicated that additional measures, such as smart meters that provide consumers with a transparent view of their energy consumption, could be introduced in 80% of EU households by 2020. In addition, it points to the following key conditions that would have to be met in the layer of renewable energy sources and their infrastructure:

- A better distribution of electrical energy will be ensured by the introduction of smart grid solutions in combination with high-voltage trans-European network (TEN-E) solutions. Market structure barriers will need to be removed to enable smooth and efficient exchanges at this level.
- There is a need to distinguish between mature (electricity) and less mature (heating) renewable energy technologies to make more efficient and effective use of these types of energy. A better differentiation between energy supply and energy demand will be needed.
- Increased investment in regional renewable energy potential, e.g. wind and solar potential in southern regions, or biomass in forested regions where potential is still untapped.

- The regions that are the most vulnerable in terms of energy supply shortages and dependence on fossil fuels should be supported by the EU and the Member States to address this vulnerability in the long term.

It is important to mention, however, that the interviewees indicated that the national RES targets met the expected climate targets despite the shortcomings and inadequacies in the energy infrastructure.

3.2.2.4 Integration

In order to achieve the goals indicated in the next iterations of the Renewable Energy Directive and the other strategic documents indicated above, it is crucial to integrate all these activities, in addition to the actions mentioned above.

The problem of integration was evident in the debate over the introduction of a carbon tax (although many economists argued for a tax rather than renewable energy contributions, efficiency improvements, or emissions caps). Verzijlbergh et al. (2017) points out the following key areas where a more integrated approach is needed, in particular, in order to achieve the main policy goal of a transition to a renewable, affordable, and reliable energy system:

- Changes to the design of short-term markets.
- Coordination between flexible resources and network management.
- Flexible resources and CO_2 policy.
- Carbon policy and RES support schemes.
- International harmonization of energy policies.
- Social acceptance and a renewed perception of the energy system.

In-depth qualitative interviews with experts on European climate policy show that they identify the following sectors as brakes on energy system transformation. For the period of 2005-2020, these are mainly transport, buildings and agriculture.

The White Paper on Transport (European Commission, 2011) stated that if we would have continued with business as usual, oil dependency in transport could still be just under 90%, with renewables only marginally exceeding the 10% target set for 2020. CO_2 emissions from transport would still be a third higher in 2050 than in 1990. However, it is worth noting that the White Paper, published just two years after the first Renewable Energy Directive, makes virtually no mention of the use of renewable energy in transport. This document was later evaluated in detail by (Tsamis et al., 2021).

Renewable energy organisations have been talking for years about the importance of decentralising power generation and producing energy directly at the point of use, which would allow full public participation in energy market structures. Over the years, grassroots initiatives

by individuals and small businesses have emerged in Europe to invest their own capital in the energy sector, both in the area of energy production and in the area of energy distribution and efficiency.

Germany has been at the forefront of implementing community energy projects. In 2012, almost half of the photovoltaic, biogas, biomass and wind farms were financed by citizens (Jankowska, 2014). Communities enable the development of sustainable technologies and can bring many benefits to the local economy.

Europe's centralised electricity system is facing quite a challenge in the face of the coming changes and the need to use more energy from renewable sources. The growing use of oceans has gradually necessitated a deeper consideration of the role of energy consumers in the building market (European Committee of the Regions, 2018).

The concept of Energy Communities and the legislation necessary for their introduction have been implemented in the EU through the adoption of the Clean Energy for all Europeans package. Included in the Directive on common rules for the internal market in electricity (EU 2019/944), the legislation defines a local energy community as "local energy community" means: an association, a cooperative, a partnership, a non-profit organisation or any other legal entity that is effectively controlled by local shareholders or members, is generally value rather than profit oriented, and is involved in distributed generation and in carrying out the activities of a distribution system operator, supplier or aggregator at local level, including across borders" (Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on Common Rules for the Internal Market for Electricity and Amending Directive 2012/27/EU (Recast) (Text with EEA Relevance), 2019).

The second definition is contained in the Directive on the promotion of the use of energy from renewable sources: '"energy community' means a legal entity: (a) which, in accordance with the applicable national law, is based on open and voluntary participation, is autonomous, and is effectively controlled by shareholders or members that are located in the proximity of the renewable energy projects that are owned and developed by that legal entity; (b) the shareholders or members of which are natural persons, SMEs or local authorities, including municipalities; (c) the primary purpose of which is to provide environmental, economic or social community benefits for its shareholders or members or for the local areas where it operates, rather than financial profits" (Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the Promotion of the Use of Energy from Renewable Sources (Recast) (Text with EEA Relevance), 2018).

EU rural development policies included measures that encouraged the use of renewable energy. However, the European Court of Auditors denoted (ECOA 2018) that renewable energy policy is not explicit enough in establishing the conditions for linking renewable energy to rural development successfully. This is an example of a policy area where further integration is needed. The European Agricultural Fund for Rural Development (EAFRD) has not been significantly used

to support the EU efforts towards renewable energy goals. The performance framework of the 2014-2020 programming period was an improvement over 2007-2013.

3.2.3 Related relevant outcomes of achieving a share of 20% RES in final energy consumption in 2020

Macroeconomic impacts

Multiple studies indicate that that there is a positive impact of renewable energy consumption on economic growth (Alper & Oguz, 2016; Lutz & Lehr, 2015; Soava et al., 2018). Sustainable Development Goal (SDG) 8G (economic growth) and SDG 12 were considered complementary in achieving a lower renewable electricity price in the EU (Swain & Karimu, 2020). Accelerating the deployment of renewable energy has the potential to stimulate economic activity and the creation of new jobs, which would have much wider social benefits for the EU and its Member States. Furthermore, the distributed nature of many renewable energy technologies and the increased use of domestic biomass production under the REmap scenario could be a driving force for economic development in depressed regions and rural areas. Renewable energy can also make an important contribution to reducing energy poverty in the EU in combination with energy efficiency measures (IRENA, 2018).

The results showed by Khan et al. (2020) indicates that higher public health expenditure and poor environmental performance harm economic activities in terms of inefficiency and low productivity of labour. Future policy oriented studies on the macroeconomic impact of RES should employ more focused and detailed analyses utilising econometric methods (Alper & Oguz, 2016).

Impact on health

The link between renewables and health is related to the effects of air pollution, which renewables reduce. It is clear that emissions from conventional energy production using fossil fuels (coal, lignite) are harmful to the climate because they emit large amounts of CO_2. Renewable energy can benefit public health and the climate by displacing emissions from fossil-fueled electricity generating units (EGUs). Benefits can vary significantly depending on the type and location of the renewable energy installation, due to differences in electricity generation or savings by location, characteristics of the electricity grid and displaced power plants, and population patterns. Due to differences in the amount of electricity generated or saved and the characteristics of displaced EGUs, benefits will vary by location within a transmission area (Buonocore et al., 2016). This will help to reduce the number of premature deaths, heart attacks, asthma exacerbations and hospital admissions for cardiovascular or respiratory problems ('Clean Energy & Health', 2019). Renewable energy sources can help to improve air quality and human health, for example by providing electricity or heat without combustion. Therefore, the most effective technologies for reducing emissions of air pollutants associated with most combustion processes are wind, solar PV, geothermal, heat pumps or solar thermal. They include SO2, NOx, PM10 and PM2.5, which are ultrafine particles with a diameter between 10 and 2.5 micrometres. By paying attention to the different composition of renewable fuels and technologies; the level of abatement installed

compared with the fossil fuel technologies substituted and the characteristics of the replaced fossil fuels. Policymakers can maximise the climate and health benefits of the energy transition (EEA, 2019). A more detailed assessment of public health benefits related to the use of renewable energy under US conditions is presented in the United States Environmental Protection Agency (EPA, 2021).

The demonstration of the impact of renewable energy use on health care spending may be a motivator for further investment in renewable energy in countries that are lagging behind. This relationship may be because countries that spend a higher percentage of GDP on health care are more developed and wealthier, and thus more likely to invest in renewable energy. However, to get a full picture of the impact of the use of renewable energy on health, further research needs be carried out to determine the exact coefficients for the impact of the use of renewable energy sources on health care expenditure (Sasmaz et al., 2021).

Impacts on competitiveness

Renewable energy sources are rapidly becoming less expensive than conventional power generation technologies. The cost of renewables has fallen much further and faster than fossil fuel prices have fallen in recent years. The cost of generating electricity from renewables became comparable or lower than that of conventional technologies (IRENA, 2018). The study by Ntanos et al. (2018) showed that there is a long-term correlation between renewable energy and gross fixed capital formation and labor force. Their results also show that there is a higher correlation between renewable energy consumption and economic growth for countries with higher GDP than for those with lower GDP.

The International Monetary Fund (IMF) indicates, credible climate policies can incentivise investment and R&D in carbon-neutral technologies and accelerate the shift in consumption patterns towards low-carbon alternatives. International experience shows that rebating tax revenues to low-income households (who are bound to suffer most from new carbon prices) helps to build acceptance and credibility of such policies (IMF, 2022). This also applies to appropriate policies related to RES, and the related competitiveness of the EU competitiveness.

3.2.4 Concluding observations on the qualitative assessment of the EU climate policies from the goal of achieving a share of 20% RES in final energy consumption in 2020

In the first part of the analysed period (especially the first years after 2005), RES were not directly linked to climate policy as we understand it today, rather to environmental concerns. The nomenclature changed over time, the closer we got to 2020, the more RES were understood as an element of climate policy. Infrastructure, in particular, was not an element of climate policy at the time, rather it served as a tool for economic growth and increasing the competitiveness of the economy. Its role in achieving climate neutrality was recognised in the debate later, especially after the Paris Agreement.

The European Union was at the forefront of the global renewable energy revolution between 2005 and 2020. The EU policies played a key role in creating an ecosystem for the investment in renewable energy sources at a time when they were not economically mature technology. The level of investment was highly dependent on and was strongly correlated with direct financial support. During the initial period of development subsidies were key, however with increase of profitability other factors started playing a bigger role (such as grid access and curtailment or land use regulations)

Regarding political will at the EU level, it was strong and determined in the 2005-2020 period. Admittedly, there were differences between countries where this will differ, but some consensus managed to emerge. The question is whether, under those political conditions, a more ambitious consensus was possible, taking into account differences between countries. It could have provided new opportunities for investment development in RES

Given that the RES target was exceeded, the overreaching conclusion should be that European regulatory framework for RES development was resilient enough to provide set ambitions considering other non-regulatory factors that have contributed to or impeded the achievement of this objective. Hence, the efficiency and effectiveness of climate policy on a general level needs to be assessed positively.

However, one should not draw too far-reaching conclusions for the future, as crises have increased (COVID, Russian-Ukrainian war) and meeting future climate targets will require avoiding the shortcomings and limitations of EU climate policy that occurred in the 2005-2020 perspective under discussion. The targets may have been achieved with easy resources, and future targets will face different challenges and conditions (not only economic and political, but also social). This makes it all the more important to avoid shortcomings in innovation, investment, infrastructure and integration for an effective and efficient transformation towards a low-carbon and climate-neutral economy in the European Union.

3.3 Target: to improve energy efficiency by 20% in 2020 relative to reference scenario

3.3.1 Assessment of the design and implementation of the policy mix to improve energy efficiency by 20% in 2020 relative to reference scenario

The EU Energy Efficiency Directive uses a very broad definition of 'energy efficiency', which means the ratio of output of performance, service, goods or energy, to input of energy (Erbach, 2015). According to Brockway et al. (2021), energy efficiency improvements reduce the effective price of energy services, such as heating and lighting, and hence encourage increased consumption of those services, which in turn will partly offset the energy savings per unit of the energy service. Energy efficiency also aim to improving energy security, improving competitiveness, and what is

crucial from the perspective of this project - energy sustainability (including lower levels of fossil fuel-based energy consumption). The EU has adopted an array of policy measures to improve energy efficiency cutting across multiple policy sectors and has agreed on overarching energy efficiency targets. Until 2020, The EU has devoted itself to improving energy efficiency by 20%. According to the European Commission (2020), primary energy consumption has decreased by approximately 9% and final energy consumption by about 6% in the EU countries during the 2005–2016 period. This indicates that the recent energy efficiency policies of the EU countries play a crucial role in the region's energy consumption mix. However, the policy design and implementation have faced many challenges that lowered their potential.

In terms of the EU energy efficiency architecture, this analysis is predominantly focused on three directives and their developments during the period of 2005-2020, i.e.

- Energy Efficiency Directive (2012/27/EU),
- Energy Performance of Buildings Directive (2010/31/EU & 2018/844/EU),
- Ecodesign Directive (2009/125/EC).

Energy Efficiency Directive (EED) puts in place several important provisions to be implemented by Member States including the requirement to establish binding national energy efficiency targets (Article 3), national building energy efficiency strategies (Article 4), a requirement to renovate 3% of public sector buildings each year (Articles 5 and 6), the need to establish energy efficiency obligation schemes (Article 7), and provisions for auditing and metering (Articles 8-12). The most important Article of the Directive (Article 7) requires Member States to implement Energy Efficiency Obligations and/or alternative policy instruments in order to reach a reduction in final energy use of 1.5% per year (2012). Article 7 is expected to deliver more than half of the required energy savings of the 20% reduction target and is therefore can be considered as the most important component of the EED in terms of its contribution.

Within the buildings sector, the Energy Performance of Buildings Directive (EPBD), in particular its most recent recasts (2010/31/EC and 2018/844/EU), is the most important piece of legislation at the EU level delivering minimum energy efficiency standards for buildings. The EPBD is not setting EU-wide standards because of the variation of building types, climate, and construction techniques across the whole EU. Instead, it requires each Member State to set its national building standards by calculating cost-optimal minimum energy performance requirements for new as well as renovated buildings. However, the requirements of setting national standards may not reflect the realised energy performance (Burman et al. 2014).

Finally, Ecodesign Directive (2009/125/EC) establishes a framework to set mandatory energy performance requirements for energy-using and energy-related products. In contrast to EPBD, this is a requirement that is harmonised at the EU level. The Directive covers more than 47 product groups (such as heating systems, lightbulbs, white and brown goods, motors, etc.) and the minimum standards are constantly being amended as the market average in terms of energy

efficiency improves over time. By setting minimum standards, the Directive forces manufacturers to design their products in a more energy-efficient way than they might do otherwise. However, the Directive is a framework directive and does not set the product standards directly. Instead, the standards are established through the so-called comitology procedure and implementing measures involving studies, impact assessments, and consultations with stakeholders. From the perspective of this project, we focus only on a framework rather than product-specific requirements.

3.3.2 Main insights from the 4i perspective

3.3.2.1 Innovation

Looking separately at each of the selected policies, the EED has not stimulated directly new technologies that would foster the goals of climate neutrality well enough at the pace that is required to fully fulfil the goals of climate neutrality. It has provided rather minimum energy efficiency standards and labelling for a variety of products. In addition, it requires Member States to introduce national guiding plans that set the standards for governing energy efficiency locally. However, according to Rosenow et al. (2016), the attitudes toward the EED have differed between various countries. An analysis shows that Member States have taken very different approaches with some using up to 112 policy measures and others just one which, too, seems like a barrier when thinking about the path to achieve climate neutrality. Therefore, the contribution to improving energy efficiency at the EU level may be unevenly distributed across Member States. In addition, these standards presented in the EED, however, have provided some technological solutions, such as combined cycle gas turbines with heat recovery, fuel cells, or microturbines, but it is the introduction of new technologies rather than replacing and updating existing ones. This aspect may be considered a potential financial barrier to implementing standards required in the EED via national plans.

From the perspective of the EPBD, the new minimum requirements for new buildings, including the increase of nearly zero-energy buildings have put an emphasis on implementing innovative solutions. The Directive has required ambitious building codes forcing the construction industry to build more energy-efficient buildings over time and banning construction types that are less efficient than the minimum requirements. Banning construction types that are more energy-consuming and replacing them with new more efficient ones is an important aspect of transformative change. In this vein, Kivimaa and Kern (2016) argue that transformative change for example in building energy efficiency can only be achieved through a mix of instruments that support innovation (creation) as well as instruments that undermine currently dominant high-energy practices (destruction). In addition, the 2018 revision includes long-term renovation strategies. The directive introduces thus the need for technological innovations, such as a higher degree of digitalszation by encouraging the integration of renewables in smart grids and smart-ready buildings. However, what is missing is how consumers should be encouraged to invest in

such technologies. In this regard, the burden of how the implementation looks remains in the gesture of member states.

Looking at the Ecodesign Directive, similarly to the EPBD, contributes to removing the least energy-efficient products from the market. However, the Directive does not have high relevance from the perspective of technological innovation. The Directive is more focused on the dissemination of existing technologies. As the Directive proposes a general framework for setting product-specific requirements, it provides a new governance tool that is an important step that shifts a paradigm in the behaviour and practice of manufacturers and importers. However, as most product categories have already had energy-efficient products before the adoption of implementing measures (Centre for Strategy and Evaluation Services, 2012), its relevance regarding transformative change may be questioned. In addition, for some product categories (e.g. television sets), the market is characterised by rapid technological change. As a result, the development of the implementing measures is slower than the improvements in energy efficiency. As a result, the requirements have been lagging behind technological changes even before they came into force. Another barrier involves the fact that the scope of penalties for products (including components and sub-components) that do not comply with harmonised ecodesign standards (described in separate documents) depends on EU Member States.

Following Geller and Nadel's (1994) classification of transformative public policies, EU energy efficiency policies provide codes and standards to eliminate inefficient technologies and practices rather than developing new measures or facilitating their commercialization. While there are such programmes like The Horizon 2020 Energy Efficiency (2016-2017) aimed to support research for innovation, the shifts have been rhetorical rather than substantive (Young, 2015). While, as this is presented above, the aforementioned policies required the Member States to implement various energy efficiency standards nationally, this process is not equally harmonised across the whole EU. This is confirmed by our interviewees. Some respondents argue that energy efficiency is an area that is very difficult from a regulatory standpoint and is of little use to ruling politicians and individuals, and thus there is not enough political will and interest to implement specific EU standards at the national level. In addition, some other interviewees point out that the problem does not lie in the lack of EU legislation, but it has always been more about implementation into more sectoral and legislative instruments at the member-state level.

3.3.2.2 Investment

Until 2020 energy efficiency was rather scarce in terms of EU investment measures. In particular, it concerns the instruments that can foster individual actions and contribute to the improvement in saving and shifting energy towards renewable energy among end-users. The existing patterns of behaviour in the industry and existing regulatory practices may favour fossil fuel-based energy. While there are initiatives that promote customer-side efficiency resources (e.g. "Efficiency First" principle, 2018), this issue is not sufficiently present in the analysed policies and had a limited impact on their performance prior to 2020.

Based on the existing literature, the non-adoption of investment opportunities that leads to the energy efficiency gap is largely related to financial factors. One of them is the fact that investment costs are higher than those expected by technological experts (Dennis, 2006). This is an effect of "hidden costs" such as a lower level of energy service. Moreover, investments in energy efficiency have a low level of certainty and a lack of profitability due to energy prices. In addition, asymmetric information between consumers and the industry (or even the administration of tenant buildings) has led to the principle-agent problem. This means that implementation of measures directly required by given directives or national plans may be difficult. Even if consumers could have been willing to make use of energy-efficient investments, decisions made by their principals undermine this opportunity.

In fact, many representatives of the industry do neglect the non-energy benefits of investing in energy efficiency (Nehler, 2018). They include labor productivity, decreased operation and maintenance costs, and a decrease in waste management costs (Pye & McKane 2000, Finman & Laitner, 2001).

The obligation schemes that are requested in the EED have created an important instrument that fostered the market for energy efficiency. Some industries consider obligation schemes as an impactful way to encourage suppliers to adapt their business model from mainly selling electricity to selling services, such as for installations that reduce the energy bill. However, as it was stated in interviews with stakeholders, the Directive has faced many implementation barriers and thus did not encourage the industry to make investments in energy efficiency a profitable business. One such barrier that was the most often highlighted is the fact that the timeframe has made it difficult to attract investment in the long term.

With respect to the obligation scheme, the Directive has proposed various solutions that can have an impact on investment in energy efficiencies such as energy or CO_2 taxes (a levy on the energy and/or carbon content of fuels above minimum EU requirements), fiscal incentive (such schemes provide monetary support from public sources that are allocated either on the basis of application), or voluntary agreements (agreements by a sector group with public authorities in which they commit to reducing end-use energy consumption over time).

Considering the energy efficiency in buildings, according to the Energy Union Report (European Commission, 2020), making the renovations of buildings with a large cost-effective energy-saving potential will be the biggest challenge in the coming decades. In this regard, the lack of attractive financial instruments on the market is emphasised as part of the reason for the limited renovation rate. On the other hand, the report has noticed that the introduction of national certification schemes in the EPBD has contributed to encouraging consumers to buy or rent more energy-efficient buildings and to sending a demand-driven market signal regardless of the involvement of investors and building administrators. However, some of our respondents have emphasised that it is not the most efficient way, despite geographical differences, to have various national plans to foster energy efficiency in buildings as it is difficult to control where the flows of EU funds actually can go: "Why do you need every Member State to come up with its own building energy

efficiency financing scheme? Why can't you have just one for the EU, and that's because in Hungary they are trying to do it, but they never managed to create one. […] And, you know, these EU funds are being stolen like there is no tomorrow."

In terms of boosting investments in renovations of buildings, the EPBD has required Member States to introduce mechanisms that encourage small and medium-sized enterprises and that can contribute to lowering the perceived risk of energy efficiency operations for investors and the private sector. They were also obliged to involve public funding to leverage additional private-sector investment or address specific market failures. The EPBD has also emphasised that Member States in their aforementioned national strategies need to provide incentives and the mobilization of financial institutions to improve the efficiency of energy-saving renovations. While the Directive itself has aimed to overcome existing barriers such as industrial focus on the financial aspect of investment, there are still some obstacles that reduce its potential. Mainly it refers to the implementation of national strategies. Energy Union Report (European Commission, 2020) emphasises that its further relevance can be extended by taking financial institutions on board and helping the industry to provide more efficient support. However, as is emphasised in our interviews, financial institutions also are focused on the aspects related to financial risk without looking at potential long-term benefits beyond them.

On the other hand, in order to overcome the cross-national variation of implementation renovation-related requirements, the EU introduced financial instruments such as The Smart Finance for Smart Buildings (SFSB) initiative and the European Energy Efficiency Fund (EEEF). The former is aimed at making energy efficiency investments in both commercial and residential buildings, more attractive to private investors, through the intelligent use of EU funds as a form of guarantee. The instrument's main objective is to provide better access to finance for both private individuals and enterprises through capital relief and loss protection via the provision of a capped guarantee for investments related to the building envelope and investments related to the building system. On the other hand, the EEEF provides an opportunity for a public-private partnership open to investments from institutional and private investors, international financial institutions, and donor agencies. Eligible energy efficiency investments include efficient central district heating networks, energy efficiency measures in public and private buildings, and efficient renewable energy technologies (Lucha et al., 2016). The fund provides debt and equity to municipal, local, and regional authorities as well as to utilities, housing associations, energy service companies, and other private entities that act on behalf of public authorities.

A similar problem, as in the case of the EED and EPBD, is observed in the case of the Ecodesign Directive. The Directive has emphasised the Least Life Cycle criterion (i.e. the product configuration in which the overall costs of the product through its whole life cycle are reduced to a minimum, meaning that the additional investment costs are more than outweighed by reduced energy and other costs during the estimated product lifetime), which requires producers for additional investment in order to adjust the level of energy-efficiency for their products. However, based on previously available interviews with representatives of the industry (Centre for Strategy

and Evaluation Services, 2012), this criterion can be associated with below the performance of the average product in the market due to the low level of implementation and lack of considering non-financial benefits of such investments. Especially since producers have been entitled to a period of three to five years before ensuring compliance with the regulation. This long period can make the specific energy-efficient product outdated when it enters the market and thus may risk low customer demand.

3.3.2.3 Infrastructure

To foster sustainability, reduced environmental impact, and improve energy efficiency in the transport sector climate-related EU policies follow two main principles: shift person and good transport towards low carbon and energy efficient transport modes (modal shift) and improve energy efficiency and reduction in the carbon intensity of vehicles.

However, there was no specific energy efficiency or reduction target for the transport sector on the EU level. Most policies focus on greenhouse gases rather than energy consumption. Although, as the automotive industry has moved towards alternative fuels, other phases are becoming more important. These include the production of vehicles and fuels and disposal phases.

Under the EED, EU Members States are required to set indicative national energy efficiency targets that include some standards related to the improvement in passenger and freight transport. Considering the significant contribution of the transport sector to the EU's final energy consumption and the expected growth in demand for transport in the coming years, the efforts to improve the energy efficiency of the transport sector should be a key priority. However, the magnitude of implemented measures varies between countries. According to Ntovantzi et al. (2015) who have analysed the National Energy Efficiency Action Plans, the transport sector is not the highest priority sector for national policies on energy efficiency. Instead, there is more focus on targeting the building sector, in particular residential buildings. The reason behind the difficulties of introducing transport policies that target energy efficiency is the high cost of these policies, including requiring large infrastructure investments. Most Member States, following the implementation of the EED, introduced in their agenda such measures like the improvement of vehicle efficiency (labelling, old car scrappages, annual car tax), shift towards more environment-friendly means of transport (reinforcement of the rail and public transport), consumer information. The incentives for the use of public transport are rarely described in these plans. The vast majority of Member States have abstained from the idea of including in their plan obligations imposed on transport fuel suppliers or carbon reduction schemes for industrial and commercial organisations such as logistics, haulage, or taxi companies.

Concerning the Ecodesign Directive, it does not focus on transport per se, and thus it is marginally relevant from the perspective of infrastructure. This Directive only refers to the plan of implementing measures in order to make cost-effective reductions in greenhouse gas emissions for vehicles. However, the Centre for Strategy and Evaluation Services (2012) argues that the Ecodesign rules significantly accelerated the phase-out of the less efficient motors. By 2020, 40%

of motors were equipped with variable speed drive as suggested by the Ecodesign requirements. The Ecodesign Directive is also considered to contribute to saving energy consumption in buildings due to requirements for product families in lighting, space heating, and water heating products. They account for 55% of the savings (Van Holsteijn & Kemna, 2016).

The revision of the EPBD (2018) introduces binding obligations on electro-mobility requirements in buildings. The EPBD introduces a "'smartness indicator" and sets clearer requirements for national databases on energy performance certificates. In terms of electro-mobility, the EPBD requires car parks of non-residential buildings to be equipped with at least one recharging point, and in new substantially renovated buildings, all parking spaces should be equipped with ducting infrastructure. However, the renovation measures are only limited to the parking lot or the electric infrastructure of the building. In addition, while they are applied for newly and heavily renovated buildings with more than 10 parking lots, it does not apply to the existing and not fully renovated buildings. From the perspective of transformative change, charging points play an important role, especially considering that 90% of the charging takes place in private spaces and buildings – overnight at home or daily at the workplace (Platform for Electro-Mobility, 2018).

In addition, both the EED and EPBD provide a requirement for promoting efficiency in heating and cooling. District heating (DH) networks are regarded as a key element in the transition of Europe's heating sector. In its Heating and Cooling Strategy (European Commission, 2016), the European Commission acknowledges DH systems as key infrastructures in densely populated areas to reduce energy dependency, cut costs for households and businesses, and deliver significant GHG reductions. The infrastructure assets associated with heating systems are capital-intensive and can generate long-term lock-in effects. Moreover, as in the case of any infrastructure, they may have severe environmental and societal impacts, such, as landscape deterioration. Therefore, it can be argued that heating systems should include a societal perspective and be under explicit consideration of non-monetary impacts.

While the EED requires "comprehensive cost-benefits assessments" of the potential for efficient district heating systems by Member States, it is only focused on newly planned systems that are subjected to major refurbishment. Similarly, the EPBD emphasised regular controls and review of cooling and heating systems. Provisions are limited to supply-side efficiency and disregard the contribution of demand-side efficiency measures. Instead of a societal perspective, a business economic perspective is prescribed, and thus, not only the end-use side of efficiency (e.g. thermal refurbishment of buildings) is neglected but also the demand side. The latter includes, for example, achieving lower leakage rates and heat losses, reducing operating temperatures, adapting piping dimensions and hydraulics, reducing oversized pumping capacity, replacing pipes, and integrating more efficient supply technologies (Rutz et al., 2019). The gap between the supply and demand side is even wider (Harrestrup et al. 2014). The reason behind it is the fact that the EED and EPBD require Members States to come up with national strategies but the implementation of heating and cooling systems in Europe is traditionally under the municipalities' responsibility. As a result, there is more emphasis on economic viability and thus the extent to which it can compete with alternative forms of heat supply (individual gas boilers, heat pumps, etc.).

3.3.2.4 Integration

Energy efficiency plays an important role in cross-sectoral integration, in particular concerning energy system integration. Energy system integration can in its simplest form be understood as connections between energy carriers (heat, electricity, and gas) and final energy-consuming sectors (buildings, transport, and industry). Here it is important to mention The Clear Energy for All Europeans package (CEP) which includes documents that are part of the analysis (the EED, the EPBD, and Ecodesign). This package supports policies for renewable energy deployment and energy efficiency actions and actions to promote smarter energy use and power system integration of renewable energy and thus the reduction of GHG emissions as well. This package, which was adopted in 2019, plays an important role in integrating various aspects of energy efficiency. It aims to consolidate scattered national obligations and reporting and allows for their better harmonization.

Mainstreaming of energy efficiency has a fundamental importance in terms of integrating electricity and gas systems, or electrification of heat and transport. Revised versions of EED and EPBD (2018) are part of the CEP. The connection between these two acts allows them to complement each other and generate symbiosis in terms of creating requirements for heat systems in particular in the building sector. For instance, Article 7 of the EED requires the achievement of a cumulative energy savings target by 2030; this requirement drives to a large extent the policy measures in the building sector. The energy performance of buildings depends not only on energy savings but also on energy sources. Therefore, the EPBD is also linked to the Renewable Energy Directive and the Alternative Fuels Infrastructure Directive. Reforms made under the CEP contribute also to active consumers and Citizen Energy Communities to participate in markets, which can create real energy efficiency opportunities for citizens and businesses alike. However, as it was mentioned before the focus on the demand side is rather low in the EPBD and EED. While these Directives refer to the "Energy First" Principle, the demand-side efficiency measures are neglected. Energy efficiency has to be part of energy system resource planning so that energy efficiency resources are considered within existing investment decision-making frameworks. From this perspective, the integration between boosting investment in innovative solutions that can contribute to more effective usage of renewables is also limited during the period 2005-2020.

In addition, policies related to energy efficiency have a particular significance for fostering the circular economy. For instance, established in 2015, the European Circular Economy Action Plan addresses the economic cycle from production to consumption, repair, and remanufacturing, to waste management and secondary raw materials. Thus, the Ecodesign Directive is directly related to the Plan and contributes to promoting better product design, which aims to improve the efficiency and environmental performance of energy-related products. As the Ecodesign Directive is a framework for making product-specific requirements, it provides an incentive for better harmonization of the market. in particular, considering the challenge of various initiatives of individual Member States that could cause a fragmentation of the market. Moreover, it is also an

important intervention in the global context. The Directive can contribute to various actions that may lead to the harmonization of product specifications between the EU and other important manufacture-based economies.

3.3.3 Related relevant outcomes to increase energy efficiency by 20% in 2020 relative to reference scenario

Macroeconomic Impacts

Energy efficiency investments may have an immediate impact on the economy. There are various explanations for that (Pehlivanoglu et al. 2021). Firstly, energy efficiency improvements encourage the company's innovation and technology development, thus enabling less energy consumption. This contributes to the reduction of the company's energy demand, and in turn, it can reduce production costs. Thus, the production power and profitability of companies increase, so they can become more competitive in export markets. Secondly, these policies can generate new markets for energy-efficient technology and products. Therefore, increasing investments in the production of products with high-energy efficiency can contribute to economic growth. Thirdly, energy efficiency improvements reduce energy expenditures, particularly in energy-importing countries, and may result in more investment in other prioritised fields that would contribute more to economic growth, such as education and health, in the long run. Overall, according to Næss-Schmidt et al. (2018), the energy efficiency investments considered to be about EUR 89 billion in total, will bring an economic stimulus of about EUR 135 billion, corresponding to 0.9 percent of the EU GDP. In 2030, this can lead to an increased labour demand of about 2.3 million job-year and an increase in GDP of EUR 160 billion.

Health Impacts

Energy efficiency improvements via housing renovation may contribute to reducing energy poverty and thus relevant health consequences, In the EU context, this refers to a high share of energy utility bills in total household income, relatively low income per household combined with inadequately low indoor temperatures. Exposure to lower temperatures can affect physical and mental diseases (Gilbertson et al., 2012; Howden-Chapman et al., 2012), including the elderly, children, and pregnant women (International Energy Agency, 2014).

Indoor air quality may be also affecting health due to the poor quality of fuels and technologies used in domestic heating and cooking (Wilkinson et al., 2009). Except for inaccurate heating sources, house furnishing and building materials may be a cause of the low level of indoor air quality (World Health Organisation, 2010). Therefore, Ecodesign Directive contributes to setting up requirements that may reduce the pollution of various product groups. On the other hand, the EED and the EPBD set up compulsory inspections of heating systems and put on Member States requirements of creating and implementing measures that improve energy efficiency and thus reduce the negative impact of energy-intensive products related to the housing and construction sectors.

Distributional Impacts

According to the European Commission (2020), investing in energy efficiency measures for vulnerable groups can decrease household energy costs, as well as deliver important energy savings. Here the energy efficiency first principle is guiding such initiatives discussed in this chapter. The EED includes specific requirements to implement energy efficiency measures among vulnerable households. Based on the EPBD, members states need to set up national measures that reduce the risk of energy poverty in their long-term renovation strategies. The European Commission also recommends introducing mandatory renovation or minimum energy performance requirements through the EPBD. This could have a positive impact on low-income households that often live in the worst-performing buildings. Proper implementation of these initiatives could benefit such households from the energy transition by giving them access to affordable energy-efficient buildings and renewable energy. Especially considering that renewable energy may be more affordable than fossil fuels in the long run.

However, during the analysed period (2005-2020), there have been limited measures that aim to mitigate the uneven effects of the energy transitions, including such that target actions at the local level. The policies implemented until 2020 mostly bring about socio-economic changes whereby the cost and benefits are not always evenly distributed (Noka & Cludius, 2021). In addition, while each Member State was required to implement specific measures on its own, a stricter common EU framework could benefit from reducing cross-national differences. However, this issue can be understood as mainstreaming of climate policies in the area of consumer protection. The Unfair Commercial Practices Directive (2005/29/EC) emphasises the need for additional protection for vulnerable consumers (Šajn, 2021) and it is a point of the departure of understanding the distributional effects of the energy transition, energy efficiency in particular, in the vein of EU regulations on commercial relations.

Employment Impacts

Energy efficiency deployment in the buildings sector is a strategic job opportunity. As technology progresses, new opportunities will be found to improve the energy profile of the EU and reduce import dependency. The requirements on the national level create a demand for skills in energy efficiency in buildings and terms of the Ecodesign of various product groups. The reason behind it is that the improvement of energy efficiency requires substantial investments in such sectors as construction, and manufacturing – they sectors are characterised by being labour-intensive. The investments that boost energy efficiency in these sectors generate additional production, and thus new jobs. On the other hand, in contrast to the EED and EPBD, which are not particularly focused on the end-users, the Ecodesign Directive, based on new requirements for various products, requires higher consumer expenditure and thus putting more demand on construction, engineering, and manufacturing sectors. This leads to further job creation in the real economy.

Competitiveness Impacts

At its premise, energy efficiency is a way to cut the energy costs of business activities, via reducing dependence on fossil fuels, and thus boost its competitiveness. Therefore, investing in energy efficiency and transitioning towards clean energy can contribute to strengthening the EU's

technology sovereignty and thus shape a system that is more resilient to various economic and energy crises.

As the EED requires Members States to include in their obligation schemes compulsory energy audits for large enterprises every four years or to implement a certified energy management system. This monitoring verifies how high energy costs are included in the operation and output-related activities of such companies. Most large enterprises carried out at least one energy audit and auditors were trained and accredited all around Europe. Some countries, however, faced delays, especially due to the difficulty to set up a list of obligated enterprises, based on the available business registries. While the EED requires conducting energy audits, companies don't need to implement the recommendations from these reviews. In fact, in terms of the effectiveness of the Directive, one of the biggest challenges of the EED is the implementation rate from the energy audits (Stańczyk et al., 2021). In addition, the EED also encourages audits in SMEs. However, according to the existing assessments energy did not improve energy savings due to the lack of a strategic approach to energy management (IEA, 2020).

Another important aspect of boosting competitiveness via energy efficiency is increasing the competitiveness of SMEs which are more prone to build up their position in the market through energy-efficient solutions. Such companies require additional support at both the EU and national levels. However, the availability of energy efficiency audit funding and energy management training is not likely to be sufficient to unlock the potential of this group of enterprises. While the EU has further streamlined its rules on renewables and energy efficiency, especially SMEs are new to the uptake of renewable energy in heating and cooling. The industry thus far has not shown evidence of purchasing renewable heating and cooling to the same degree that it has shown an appetite for purchasing renewable electricity.

Investment Certainty

Regulatory uncertainty is considered to be the main barrier to increased energy-efficiency investment. In addition, improved standards in building codes, government awareness programmes, innovative financing methods, and support for the development of specialised energy-service companies are among the approaches that could overcome these barriers.

However, Torregossa (2015) argues, that the EU has taken some positive steps to improve regulation, but ambiguity regarding definitions of what constitutes a deep retrofiting and a "nearly zero-energy building" affects implementation at national levels. Indeed, regulatory uncertainty is a barrier to pursuing energy-efficiency investment. Furthermore, the implementation of energy-efficiency-related directives varies from one country to another, limiting the ability of property owners to achieve economies of scale across the region.

In addition, investments in energy efficiency need to be beneficial based on the potential demand. However, it is difficult to forecast the potential interest of end-users. This is especially important in the case of analysed policies during the period of 2005-2020 as they do not provide specific measures that could boost the demand of end-users and thus lead to a higher level of certainty

and make producers and financial institutions more interested in investing in energy efficiency solutions.

3.3.4 Concluding observations on the qualitative assessment of the EU climate policies from goal to improve energy efficiency by 20% in 2020 relative to reference scenario

Energy efficiency is an issue that has long been addressed in EU climate policy. The European Union has set itself and its Member States the ambitious target of improving energy efficiency by 20% in the face of increasing energy demand.

Energy efficiency is regulated in a number of directives in the areas of national policies, buildings and products, which have oblige a number of obligations and targets on Member States to be implemented in the areas of public buildings, national strategies and energy audits.

However, the increase in energy efficiency is not directly linked to the introduction of new and innovative solutions on the market. It is important to take concrete steps to reduce the energy consumption of equipment on the market, to measure it properly and to influence manufacturers and users to use energy as efficiently as possible. The solutions proposed by the EU can be applied to industry installations, equipment and buildings. This includes the introduction of general standards for the above and common regulation at European level, e.g. development of standards for buildings or electronic equipment.

An important policy challenge has certainly been to communicate that investments in energy efficiency can have a direct impact on energy and cost savings for end users. An indirect effect of investment in energy efficiency was the development of renewables and the reduction of fossil fuel consumption. The plan to improve energy efficiency was not perfect and the market did not fully understand this need. At the time of the study, the costs of inaction in this area were not high enough (e.g. the price of CO_2 emission) for entrepreneurs to see the rationale for such high investment costs. In the case of Eco designed equipment, the actions had a clear impact, as newer and better equipment appeared on the market, and end-users saw the effects of the renovations in terms of reduced heating or lighting bills, which allowed the market to expand strongly.

Policies also focused on building strong infrastructure for transport and buildings. Measures to improve energy efficiency in transport promoted modal shift and increased energy efficiency through the use of less carbon-intensive transport modes. Significant activities were also presented in the field of heating and air conditioning, aiming at modernising district heating networks, modernising heat sources and buildings renovations. Much of the responsibility for these measures has been transferred to the municipalities.

Improving energy efficiency is an overarching objective for all sectors of the economy. The measures proposed by EU policy have a direct impact on all these sectors, both in terms of energy

production and use, and in terms of reducing emissions and energy costs. Actions in all these sectors are primarily based on improving energy efficiency.

The principle 'energy efficiency first' was established in 2018 and has been developed in years as a very important element of European energy and climate policy. The issue of improving energy efficiency is also of great importance for the development of renewable energy sources, which allow a more efficient use of the energy produced, as well as for its impact on other issues such as the economy, health and employment.

4. Lessons learnt from a qualitative assessment of 2005-2020 EU climate policy

4.1 Conclusions

The EU climate policy, which requires a very broad approach, was being implemented to such an extent for the first time, and there was no previous experience. Therefore, its formulation and implementation were in the nature of learning by doing. An example of this was the EU ETS, whose development was a learning curve. The first phase was a pilot to test the system and improve it. Numerous reforms were then introduced based on reviews of previous phases.

The formulation and implementation of climate policy instruments meant changes in thinking, this was what the climate and energy agenda required. This was quite fundamental. Lack of experience, both on the side of the EU institutions, business and society, as well as the central and local administrations of the member countries, led, on the one hand, to the formulation of not very ambitious goals, and, on the other hand, gave rise to resistance and concerns about the political, economic and social costs of such an energy-climate transition. At the same time, financial institutions like banks not only lacked developed ways of proceeding, but also overestimated the risks of the new climate area of activity. In the final design of climate policy instruments, compromises to increase political acceptability played an important role. Despite these difficulties, favorable direct and indirect conditions were created for the development of innovation, infrastructure and investment for its implementation.

An important factor in the 2004-2013 period was the enlargement of the EU and the entry of 11 new countries from Central and Eastern Europe with different political and administrative cultures as well as levels of economic development and civil society. With considerable effort, they not only adapted their laws to the *acquis communautaire*, but had to learn to apply them. For them, climate policy was a particular challenge.

All in all, it should be assessed that the climate policy of the period of 2005-2020 was successful: GHG emissions were significantly reduced and RES development took place.

From today's perspective, the targets for reducing GHG emissions in the energy sector or the share of RES could have been higher, and in particular the low-hanging fruit that was, and still is, the improvement of energy efficiency, was used to a small extent In the early days of climate policy formulation, it was rather sectoral in nature with weak links to many other policies that directly, and especially indirectly, addressed climate issues. The policy, in its essence, should be horizontal in nature, and such an approach was lacking in the 2005-2020 period.

Due to the magnitude of greenhouse gas emissions, as well as, to some extent, the easier possibility of reducing them, climate policy has focused on the generation and use of electricity and heat. The key instrument used for this has been the EU ETS since 2005. Carbon pricing instruments in general, and EU ETS in particular, were considered the most effective way to internalise the social and environmental cost of emissions. The first step was fuel switching in energy production, which does not require technological innovation and is based on organisational decision-making. However, this also had the disadvantage of raising production costs in energy-intensive industries, creating the danger of carbon leakage. One of the main mechanisms established to mitigate the possible effects was free allocation of allowances. However, the multiplicity and depth of changes increased the complexity of the system, making it difficult to implement. It was not preceded by sufficient time as well as an information policy to facilitate adaptation to the fast-moving changes. In addition, given the low carbon price for most of the period under review, a stronger price signal would have allowed higher levels of reductions to be achieved. This means that trade-offs that increased political acceptability played a crucial role in the final design.

An important instrument supporting the EU ETS was the NER300 programme, which focused on supporting a set of specific technologies that could potentially play an important role in decarbonizing economies. It provided an example of the interdependence between different policy instruments. In this case, the link to the EU ETS through the auctioning price of allowances significantly influenced climate policy. In this way, the NER300 played a positive role in providing the know-how to implement this type of innovation promotion policy.

Complementing the EU ETS was the ESD, which set out a linear trajectory of appropriate emission caps (annual emission allowances) for each year over the 2013-2020 period. No specific targets were set for individual sectors, leaving Member States free to choose where and how to achieve the necessary reductions. In addition, they were allowed to use flexibility instruments to meet their commitments. In this way, the ESR spurred the implementation of policies at the national level to achieve the intended reduction target.

Most of the emissions reductions since 2009 have come as a result of technological and policy changes that have enabled wider adoption of less carbon-intensive technologies. This effect was reinforced by the fact that the ESR was launched alongside other EU climate and energy initiatives as part of the 3x20 package, particularly on energy efficiency and renewable.

There was much less emphasis on transportation, whose emissions were growing, as well as on the virtually "forgotten" agriculture, whose emissions in the big picture are quite significant. This was due to the strong lobbying and political positioning of automakers and farmers. At the same time, the 2011 Transport White Paper focused on the development of a resource-efficient and integrated transportation system, rather than on sustainable mobility. It emphasised the need to integrate the East with the West of the EU in terms of infrastructure. Inequalities were reduced faster in road and air transport infrastructure than in, for example, urban mobility behavior or rail infrastructure standards. From a climate perspective, this was a negative development. In

agriculture, a monetised system prevailed, encouraging farms, including large ones, to simply benefit from per-hectare subsidies without any environmental criteria or incentives for alternative practices.

Despite the critical view of transportation as a whole, it is the regulations on limiting CO_2 emissions from new passenger cars and light commercial vehicles that have had a positive effect. The regulation in question is a good example of the use of standards as a policy instrument in the EU. In this case, the standard was set directly by the European Commission and targeted at private stakeholders, particularly vehicle manufacturers.

The experience of the ESD, as well as the RED, in which country-specific targets were set, led to a more effective impact, serving to achieve them. If further arrangements were put in place to facilitate the achievement of these goals, the effect would be more pronounced. At the same time, the lack of financial resources to implement these commitments with insufficient support for innovation made itself known.

Infrastructure solutions for climate policy require strong integration among member countries, so they are strategic in nature and require coordination. Which has not always been the case during the period under review. Difficulties in the implementation of the very important AFID lead to the conclusion of the need to build a strong relationship between the implementation of new solutions and an information policy showing in detail and precisely what the essence of the introduction of new regulations is and what benefits result from it.

According to stakeholders, the FQD failed to deliver the expected social and environmental impacts and did not provide a new impetus for the technological development of more efficient engines. Factors hindering the achievement of the goals included the inconsistency of the regulatory framework (mainly due to inconsistencies with the Renewable Energy Directive) and the low expected return on investments made by suppliers/manufacturers to reduce GHG intensity. In addition, important sustainability criteria have been introduced for biofuels so that their energy meets a number of requirements in this regard. The Directive has effectively created the necessary conditions for the development of markets for biofuels and other fuels with lower GHG intensity.

The climate policy's energy efficiency not only served to improve it, but also contributed to GHG reduction, improved energy security and competitiveness. It mainly included three directives on: energy efficiency, energy performance of buildings and Ecodesign. This indicates that it played an important role in energy policy in the region. However, the design and implementation of the policy encountered many challenges that reduced its effectiveness. For example, the Ecodesign of products is a key factor in the EU strategy on integrated product policy. Under this Directive, producers are obliged to reduce the energy consumption and other negative environmental impacts occurring throughout the product life cycle. However, penalties for non-compliance depend on the Member States. Yet, energy efficiency is an area that is very difficult from a regulatory standpoint and is of little interest to ruling politicians and individuals, so there is not enough political will and interest to implement specific EU standards at the national level. In

addition, it indicated that the problem is not the lack of EU legislation, but rather has always been a matter of implementation to more sectoral and legislative instruments at the level of Member States.

4.1.2 Innovation

Fostering innovation is one of the key mechanisms through which the carbon market can achieve decarbonisation goals. The progressive shortage of allowances created by the declining cap has generated cost increases increasing the incentive to switch to alternative technologies. The carbon market also had the advantage of reducing emissions where costs were lowest. However, this limited investment in projects that were more capital-intensive and took longer but had a greater effect in reducing emissions. The EU ETS was more effective in encouraging innovation and less so in the dissemination aspect, where targets and standards could have contributed more.

The EU ETS-related NER300 Programme provided some interesting insights into policy design and financing of innovative technologies. It focused on the demonstration and early deployment phases. The advantage of the top-down approach over the bottom-up approach was that significant resources could be invested in one or a few selected technologies that would lead to faster breakthroughs. From the perspective of the effectiveness and efficiency of the policy, it can be seen that although a very large amount of money was allocated to promote innovation, there were barriers that slowed down the process and caused some of the funds not to be spent. It is worth noting that the decision on which technologies to include was not based solely on technical or feasibility criteria, but also had a significant political component.

The vehicle emissions measures adopted provided incentives for manufacturers to develop and market low emission vehicles but may have undermined overall emissions reduction targets. Manufacturers' average actual emissions were higher than their targets, which may have delayed the introduction of fuel-saving technologies in all types of vehicles.

In the context of AFID in terms of innovation, the policy has contributed to the spread of cleaner technologies. There are various milestones in technological innovation, one of which is enabling widespread adoption of new technologies. The FQD has had an indirect impact on innovation, stemming from the development of various fuel market sectors and related technologies to meet emission reduction targets. According to an impact assessment commissioned by the EC, it has allowed for accelerated research and development of fuel-efficient technologies, as well as increased market adoption of fuel-efficient technologies in both passenger cars and light commercial vehicles.

The EU has also incorporated RES development into a broad spectrum of its research activities. However, there has been no direct link between the goal of achieving a 20% share of RES in final energy consumption in 2020 and the range of activities undertaken in research and development programmes. The Renewable Energy Directive strongly supported the development of innovation in renewable energy sources, contributing to their technological development in order to increase

the security of energy supply. It supported the promotion of the demonstration and commercialisation phase of decentralised renewable energy technologies. However, the weakness of the innovation policy as to the development of RES was that the European industry did not protect itself from competition from, for example, Asian countries. Innovation in transmission and storage technologies related to RES should have been addressed earlier, and coordination of solutions in a systems approach should have been introduced.

Much could also be achieved by supporting classic innovation activities in EU regions associated with coal and lignite mining with investment activities that support the quality of life in these areas after mining. This would reduce the social resistance of the residents of these regions, who have often been associated with the industry for generations and often cannot imagine life "after coal." Some of the problems associated with the transformation of post-coal regions would have been avoided if the new R&D and production centers and the resulting industry had been located in these areas.

During the period in question, it was difficult to expect a coherent innovation policy in a situation where 10 new Member States, differing in characteristics, resources and mentality, joined the EU in 2004. These countries were technologically backward compared to the so-called "old Europe" and found it difficult to cooperate on an equal footing. At the time, the efforts of these countries were focused on structural funds, which were aimed at equalizing their standard of living with those of the EU today. As a result, innovation policy received less attention and resources.

Looking at each of the relevant instruments for improving energy efficiency separately, they stimulated to varying degrees the development of new technologies that would advance climate policy goals. From the perspective of the EPBD, the new minimum requirements for new buildings, including the rise of near-zero energy buildings, have emphasised the implementation of innovative solutions. The Directive has required ambitious building codes forcing the construction industry to build more energy-efficient buildings over time and banning construction types that are less efficient than the minimum requirements. The Directive therefore introduced the need for technological innovation, such as a higher degree of digitization by encouraging the integration of renewable energy sources into smart grids and smart buildings. What was missing, however, was how to encourage consumers to invest in such technologies.

The Ecodesign Directive, on the other hand, helped remove the least energy-efficient products from the market. However, the directive was not very significant from the perspective of technological innovation because it focused more on the diffusion of existing technologies than on the creation of new ones.

4.1.2 Investment

EU policy could have been much more effective in preventing investment in the wrong sectors (including fossil fuels). This posed a major challenge, and taxation was one way to address it. There was no integration of solutions at the EU level, each country had its own solutions.

Fossil fuel technologies have been able to provide more cost-effective reductions than some investments in less carbon-intensive alternatives by improving efficiency and leveraging their maturity and presence and market share. The system needs to be robust and provide certainty for investors to allow for larger and riskier investments, which in turn can also provide greater reductions in CO_2 emissions. In such cases, it becomes clear that the EU ETS needed to be complemented by policies that enable transformational change through large-scale investments and channelling them into new technologies. In this regard, the NER300 Programme and more advanced policies such as the Renewable Energy Directive acted as those supporting instruments that contributed to achieving reductions. The Programme focused on supporting a set of specific technologies that could potentially play an important role in decarbonizing economies. With the launch of the Programme in 2010, the areas of CCS and innovative RES technologies were made more specific, as well as the NER300 of eligible technologies. As a result, some funds have remained unallocated for this reason, and the start of projects has been severely delayed due to difficulties in securing these additional funds.

If there is a perception that a more stringent context awaits us, with lower allowance levels and higher prices, there is an incentive to make long-term investments. However, this must be accompanied by clear signals of stability. That is, the system must be robust and provide certainty for investors to allow for larger and riskier investments, which in turn can provide greater reductions in CO_2 emissions. As such, uncertainty about the effects of climate change, future policies and evolving technology may delay the investments needed to achieve climate change mitigation.

In addition, the policies and measures reported by Member States do not provide sufficient information on their expected and actual costs and benefits. Among the four main sectors covered by the ESD (transportation, buildings, waste and agriculture), the most cost-effective reductions were found in the buildings sector, with measures in the other sectors being more costly. In particular, some measures in the agricultural sector have a very high cost per ton of CO_2 reduced.

Another key element related to investment is the role of the financial sector. The EU has done too little to try to align investment flows and climate policy. The measures taken have often been more cosmetic than effective.

A closely related issue in promoting innovation was also the expectation of future conditions. If there is a perception that a more stringent context awaits, with lower entitlement levels and higher prices, there is an incentive to make long-term investments. However, this must be accompanied by clear signals of stability. That is, the system must be robust and provide certainty for investors to allow for larger and riskier investments, which in turn can provide greater reductions in CO_2 emissions.

CO_2 emission standards have proven to be a good tool to provide investment certainty for automakers and, more importantly, their suppliers, as subsidies for electric car buyers or testing could not provide the same level of investment certainty as strict fuel efficiency standards.

The Ecodesign Directive has contributed to energy savings in buildings due to its requirements for a group of products related to lighting, space heating and water heating.

The political will on RES development at the EU level, from 2005 to 2020, was strong and determined. While there were differences between countries, some consensus was reached. However, was a more ambitious consensus possible under these political conditions, taking into account differences between countries. This could have created new opportunities for RES investment development. On the other hand, investments did not keep pace with the development of RES, there were no funds for network development and no system solutions introduced in time.

Among the sources of investment, the costs of launching energy communities should have been foreseen and taken into account. The lack of such investments often resulted in a lack of innovative energy communities.

It can be concluded that the failure to take advantage of investment opportunities that would have led to exploiting the energy efficiency gap was largely related to financial factors. One of them was that investment costs turned out to be higher than expected. In addition, investments in energy efficiency were characterised by low certainty and lack of profitability due to energy prices. However, the commitment schemes required by the EED created an important instrument to support the energy efficiency market. It has certainly been a major step toward strengthening the development of certain technologies that can be described as compatible with climate policy goals.

Stimulating investment in building renovation, the EPBD, required Member States to introduce mechanisms and remove barriers to encourage small and medium-sized enterprises to carry out energy efficiency improvements. In this regard, the lack of attractive financial instruments in the market has been highlighted as part of the reason for the limited pace of renovation. On the other hand, it was noted that the introduction of national certification schemes in the EPBD helped to encourage consumers to buy or rent more energy-efficient buildings and to send a market signal to stimulate demand regardless of the commitment of investors and building administrators.

In order to overcome the variation in renovation requirements across countries, the EU has introduced financial instruments such as the Smart Finance for Smart Buildings (SFSB) initiative and the European Energy Efficiency Fund (EEEF). The former served to make energy efficiency investments in both commercial and residential buildings more attractive to private investors through the smart use of EU funds as a form of guarantee.

The Ecodesign Directive emphasised the life-cycle criterion, which required manufacturers to make additional investments to adjust the energy efficiency level of their products. Manufacturers were given a period of three to five years to ensure compliance with the regulation. This long period could have rendered an energy-efficient product obsolete by the time it entered the market, and thus risked low customer demand.

4.1.3 Infrastructure

The introduction of the GHG emissions trading scheme made it possible to reduce GHG emissions where it was cheaper to do so, but this did not stimulate large and coordinated infrastructure investments. Therefore, a complementary instrument was needed. To this end, the NER300 Programme was launched to enable the financing of new infrastructure projects. From an infrastructure perspective, the NER300 Programme played an important role, because in most cases the technologies to be developed by the funded projects require significant infrastructure. This applies to both RES development and CCS projects. However, this does not mean that the EU ETS has not had or could not have an impact on infrastructure investment. The ability of the EU ETS to stimulate such investments was closely related to the level of emission allowance prices. A strong and stable price signal is needed for long-term infrastructure investment. However, projects requiring the most infrastructure, such as large-scale biofuel demonstrators and CCS projects, were not ultimately funded under the programme. The design of the calls, which included several conditions to ensure the distribution of funds on a geographic and technological level, as well as the need to secure private financing, also complicated the development of such projects.

In terms of investment, the establishment of infrastructure networks such as electric vehicle charging stations, for example, required significant investment that cannot be expected from private stakeholders. Having a public strategy for deployment and investment was a key element to ensure viability, as well as an attempt to avoid disparities and distributional effects associated with access to services in sparsely populated areas.

For RES development, infrastructure plays a key role. Its development was observed during the period under review, but was uneven in terms of geographic location, financing methods and sources, and regulation. Aging and requiring investment and maintenance, traditional energy infrastructure could not provide a basis for RES development. At the same time, the transition to renewable, distributed energy required a change in the architecture of the transmission grid. Insufficient capacity, especially of local grids, was a barrier. It was becoming important to write into the infrastructure solutions to mitigate the adverse, not just positive, effects of weather-dependent RES development.

From the point of view of improving energy efficiency, infrastructure measures are less important. Only the transportation sector in this context could be of greater importance. However, EU policy has placed more emphasis on the building sector, particularly residential buildings. The reason for the difficulty in introducing transport policies aimed at energy efficiency is the high cost of these policies, including requiring large infrastructure investments.

In addition, both the Energy Efficiency Directive and the Energy Performance of Buildings Directive included a requirement to promote heating and cooling efficiency. District heating networks are considered a key element in the transformation of the European district heating sector. In its Heating and Cooling Strategy, the European Commission identified district heating systems as key

infrastructure in densely populated areas to reduce energy dependency, lower costs for households and businesses, and significantly reduce greenhouse gas emissions.

4.1.4 Integration

In terms of how the policy contributed to cohesion within and between Member States, the Directive established technical requirements that could help harmonise charging and refuelling infrastructure across Member States. However, one of the main criticisms of the policy was that it has so far produced very different results from one Member State to another. The fact that the targets were to be set by each Member State has resulted in some discrepancies among them, and some of them have put forward targets that are not very ambitious.

There was overlap and inconsistency between instruments. This risk of overlapping instruments occurred among EU policies, but especially among EU and Member State policies.

As mentioned above, there was a need for complementary instruments. That is, more general instruments, such as the EU ETS, and other, more specific policies dealing with sectoral aspects or regulatory aspects, which were to be implemented at the Member State level. However, for these instruments to be effective and efficient, they must be coordinated in terms of how they contribute to a common goal.

The 2011 Transport White Paper, which concluded that we would continue the current dependence of transportation on oil, published just two years after the first RES directive, made virtually no mention of the use of renewable energy in transportation.

Renewable energy organisations have been talking for years about the importance of decentralising power generation and producing energy directly at the point of use, which would enable full public participation in energy market structures. Over the years, grassroots initiatives by individuals and small companies have emerged in Europe, investing their own capital in the energy sector, both in the areas of energy production, distribution and energy efficiency. The general trend has been to move from administratively set feed-in tariffs (FITs) to feed-in premium systems that facilitate greater market integration of renewable energy.

Mainstreaming energy efficiency is fundamental to the integration of electricity and gas systems, or the electrification of heat and transport. From this perspective, integration between stimulating investment in innovative solutions that can contribute to more efficient use of renewable energy sources is also limited in the 2005-2020 period.

Energy efficiency is an integral part of the EU's climate policy, and the issue is being mainstreamed into other areas of EU activity. Policies related to energy efficiency are particularly important for promoting a circular economy. For example, the European Roadmap for a Closed Circular Economy, established in 2015, covered the economic cycle from production through consumption, repair and remanufacturing to waste management and secondary raw materials. Thus, the

Ecodesign Directive was directly linked to the plan and helped promote better design aimed at improving the energy efficiency of energy-using products.

Mention should be made of the Clear Energy for All Europeans (CEP) package adopted in 2019, which includes the documents that are part of the analysis (EED, EPBD, Ecodesign). The package supports renewable energy deployment policies and energy efficiency measures, as well as measures to promote smarter energy use and integration of the electricity system with renewable energy, thereby also reducing greenhouse gas emissions. It aims to consolidate dispersed national commitments and reporting, and enables their better harmonisation.

4.2 Recommendations

1. A key lesson from the 2005-2020 period as to climate policy is the need to create a coherent programme not only of substance, but also to communicate with the public, local governments and business. Currently, the European Green Deal is implementing this to some extent. People and companies, despite the fact that it is complicated and technical, feel that it is something needed and important on an ongoing and long-term basis. That's why entrusting climate policy to a directorate-general or ministry is proving insufficient. What is needed is a comprehensive approach and the integration of climate into activities that at first glance do not come into contact with it, such as finance, trade, health or education. For these purposes, it is important to introduce a mechanism to control virtually all decisions made from the point of view of the impact on GHG emissions or the need for adaptation measures. To this end, it is proposed to introduce a climate test of decisions made at both the EU and Member State levels. The instrument used today for selected strategic documents, i.e. strategic environmental impact assessment, is insufficient and needs to be strengthened.
2. Climate policies, despite the need to formulate both medium-term and long-term goals, requires a flexible approach to their implementation by creating mechanisms for their modification. In this context, three key challenges can be distinguished: competitiveness, social problems and carbon regions.
3. The need to achieve climate neutrality no later than 2050, which is enshrined in the European Climate Law, requires providing individual targets to meet it. This means more ambitious targets for reducing greenhouse gas emissions (necessary reference to the available carbon budget), the share of RES, and above all for improving energy efficiency.
4. The climate agenda should not be seen as an elitist programme or one that does not take into account the diversity of individual member countries, but as one that takes into account the specifics of both individual economic sectors and the equal treatment of EU members. In particular, such a risk exists with regard to Member States from Central and Eastern Europe.

5. The EU economy and other rich countries are responsible for significant GHG emissions, even not necessarily from their territory but simply by consuming products and services produced outside of them. Making climate policy more friendly and effective in implementation requires an equal approach internationally, including historical accountability. In particular, taking into account the needs of developing countries to both strengthen their climate action, taking into account the principles of sustainable development, as well as taking into account their interests in implementing climate policy solutions with international implications.

6. The transformation of climate policy in the 2030s and 40s of this century requires a common view of all 4i's dimensions, i.e., innovation, investment, infrastructure and integration. It should be an arrangement that is not only complementary but synergistic which will consequently lead to the desired effects greater than each of these dimensions implemented separately.

7. The scale of investment in the context of EU climate policy exceeds the capacity of the public sector, there is a need to redirect private capital towards more sustainable, pro-climate investments. This requires a profound change in the way the financial system operates, as until now banks and financial institutions have made decisions based solely on their own narrow economic interests, without taking into account the interests of sustainable development and climate policy. The argument of long-term risk was often inadequate in relation to short-term revenues and profits. The situation is changing over time, with increasing political and social pressure to move toward climate neutrality in the European Union.

8. Not only in light of climate policy or the complex geopolitical situation, but also global trends, it is becoming necessary to make a change in the energy sector. It is becoming increasingly important to build energy security from the bottom up based on local self-sufficient energy systems in the hands of local communities whether in the form of civic energy communities, energy cooperatives or clusters. This means decentralising energy and energy production directly at the point of use. Over the years, grassroots initiatives by individuals and small businesses have emerged in Europe to invest their own capital in the energy sector, both in the area of energy production and in the area of energy distribution and efficiency.

9. Given the significant need to improve the energy efficiency of buildings, the biggest challenge in the coming decades will be to make the renovation of high-potential buildings cost-effective and, together with zero-energy new buildings, this will contribute to a significant reduction in energy demand. At the same time, building economic potential in industries serving this energy efficiency improvement along with the development of renewable energy installations and smart energy management.

10. it is becoming necessary to change the approach to transport policy towards reducing transport needs within the framework of spatial planning, creating sustainable mobility,

the dominance of rail and public transport, and pursuing the idea of a 15-minute city. Information policy in this regard is particularly important. At the same time, in view of the significant share of the transport sector in the EU's final energy consumption and the expected increase in demand for transport in the coming years, priority should be given to efforts to promote zero-emission vehicles and improve the energy efficiency of the transport sector.

11. It is necessary to integrate the Common Agricultural Policy with the requirements for climate protection needs. This goal is to be served by reducing GHG emissions as much as possible and, on the other hand, strengthening the carbon sequestration capacity of agricultural land. Climate action must be included as a cross-cutting priority in all areas of agricultural policy, including trade.

12. The supply of energy for transport supplied for use in any type of road vehicle, non-road mobile machinery (including inland waterway vessels), agricultural or forestry tractor or recreational craft;

13. The use of any technology (including carbon capture and storage) capable of reducing life cycle greenhouse gas emissions per unit of energy from fuel or energy supplied;

14. An indicative additional target of 2 % by 31 December 2020, subject to Article 9(1)(i), to be achieved through the use of credits purchased through the Clean Development Mechanism of the Kyoto Protocol, under the conditions set out in Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community, for reductions in the fuel supply sector.

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Appendix A Overview of qualitative assessments of EU climate policies

Summary of key conclusions from the assessments of selected important key legal acts and planning documents on EU climate policy for the period of 2005-2020

No.	Legal act or planning documents	Key conclusions	Link
1.	Development of EU ETS (2005-2020)	The design of an international carbon market entails a high level of complexity. As admitted by the European Commission (Evaluation of the EU ETS Directive - Publications Office of the EU, n.d.)and pointed out by academic literature1 in the case of the EU ETS there has been an important learning curve. In fact, the first phase was a pilot phase to test the system and improve it. In this regard, we have seen numerous reforms based on the reviews of the precedent phases. For example, moving from a Member-State-based to a centralised allocation system or moving from previous performance-based allocation to the use of benchmarks (which have in turn been redesigned). Aside from limitations related to the instrument's characteristics, the EU ETS has also needed to be adapted to mitigate how external factors affect it. Clear examples of this have been the impact of the entrance in the market of the credits coming from the Clean Development Mechanism (CDM) from the Kyoto protocol, the decrease in the price of energy from RES, or the 2008 global financial crisis. All these factors played a key role in keeping the price at very low levels for a long period. The EC reacted to this fact by first creating a short-term solution which was the postponement of the auctioning of a total of 900 million allowances until 2019-20 (then transferred to the MSR). The long-term solution was the design of a Market Stability Reserve (MSR). The MSR entered operation in 2019 and, by holding or releasing a particular number of allowances following pre-defined rules, is expected to provide the necessary resilience to the system to face unexpected shocks. Also, it must be considered that the instrument that was initially implemented in 2005 was the result of hard negotiations among the EC, the Member States and also the representatives of the economic sectors included in the ETS. That is, compromises that increased the political acceptability played an important role in the final design. Thus, it can be argued that the first phases of the ETS, while not necessarily satisfactory in terms of its impact on innovation and low-carbon investment, and thus in decarbonization, have been instrumental in achieving a refined instrument that also has, with time, gathered the necessary consensus both at the	https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/development-eu-ets-2005-2020_en

[1] Sato, M., Rafaty, R., Calel, R., & Grubb, M. (2022). Allocation, allocation, allocation! The political economy of the development of the European Union Emissions Trading System. *Wiley Interdisciplinary Reviews: Climate Change*, *13*(5), e796. https://doi.org/10.1002/WCC.796

		public at private levels. As pointed out by Sato2 some of the debates that led to substantial modifications during the subsequent reviews, where enabled by the experience in earlier phases. For example, the allocation 90% of allowances for free at the beginning was more palatable to private sectors. That leads to the question of whether the current instrument, with the latest reforms, will be a suitable instrument to achieve the decarbonization goal at the desired path. The changes made to the system and the higher prices recorded in the last few years suggest that the impact on innovation is stronger in this moment than before. Finally, there seems to be an agreement in academia that the EU ETS cannot singlehandedly achieve the EU climate goals3. Thus, although it plays a central role, it needs to be assessed in conjunction with other instruments targeted to specific sectors or specific objectives.	
2.	Decision No 406/2009/Ec of The European Parliament and of The Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020	Most of the reductions in emissions since 2009 occurred due to technological and policy changes that enabled greater adoption of less carbon-intensive technologies. This effect was reinforced by the fact that the ESR was launched alongside other EU climate and energy initiatives as part of the 2020 package, in particular on energy efficiency and renewable4. A total of 24 EU countries (all except Cyprus, Ireland and Malta) had GHG emissions in 2020 in the diffuse sectors below their national targets under the ESD5. The Effort Sharing Decision contributed to emissions reductions in the companies covered by it, so that for each percentage point increase in the stringency of the policy at the national level, the emissions of an average covered company were reduced by 6.1%. Moreover, even in countries without stringent targets, emissions from covered companies tended to be reduced more than emissions from uncovered companies, so it is possible that the Effort Sharing Directive framework incentivised the adoption of policies and measures even in countries with lax targets6.	https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0136:0148:EN:PDF
3.	NER 300 is a funding programme pooling together about EUR 2 billion for innovative low-carbon technology,	The NER300 Programme has provided some interesting insights in terms of policy design and funding of innovative technologies. In terms of policy design, one key takeaway is the fact that some of the features of the policy that seek to achieve a particular goal such as, for example, territorial balance, can affect the main goal of the policy. In this case, as detailed above, the sub conditions of the call have somewhat altered the results of the policy.	https://climate.ec.europa.eu/eu-action/funding-climate-action/ner-300-programme_en

[2] Sato, M…*op. cit.*
[3] Skjærseth, J. B. (2021). Towards a European Green Deal: The evolution of EU climate and energy policy mixes. *International Environmental Agreements: Politics, Law and Economics*, *21*(1), 25–41. https://doi.org/10.1007/S10784-021-09529-4/FIGURES/1
[4] EC (2016). Commission staff working document accompanying the document Report from the Commission to the European Parliament and the Council on evaluating the implementation of Decision No. 406/2009/EC pursuant to its Article 14. SWD(2016) 251 final.
[5] EEA (2022a). Greenhouse gas emissions under the Effort Sharing Decision (ESD). https://www.eea.europa.eu/data-and-maps/data/esd-4
[6] Gavard, C., Diethelm, L. (2022). Lessons from the EU effort sharing decision for supra-national climate cooperation: A firm-level analysis. Discussion Paper No. 22-042, ZEW. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4251608

	focusing on the demonstration of environmentally safe Carbon Capture and Storage (CCS) and innovative renewable energy technologies on a commercial scale within the EU.	From the perspective of the effectiveness and efficiency of the policy, we see how although a very important sum has been allocated to promote innovation, there have been some barriers that have slowed down the process and has cause for some funds to be unspent. The due diligence process has been very long and finding the matching funds has proved to be challenging. Considering that the instrument was supposed to ease the path for projects that in market conditions would face many risks and uncertainties, probably some of the features should have been designed to provide more flexibility and allow for a swifter process altogether. Also the assessment of the NER300 Programme serves as an example of the interdependence among different policy instruments. In this case, the link to the EU ETS via the price of the auctioning of the allowances, substantially affected the policy as, as mentioned, the available funds were significantly reduced compared to the expectations. The risks of linking different policy instruments and the according mitigation measures should be taken into account in the policy design. The Innovation Fund, that takes over the NER300 Programme, has taken stock of some of these challenges. Thus, the NER300 has had a positive role in providing the know-how to implement this type of innovation promotion policy in an effective and efficient way.	
4.	Regulation (EC) No. 443/2009 of the European Parliament and of the Council of 23 April 2009 setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO 2 emissions from light-duty vehicles. Regulation (Eu) No. 510/2011 of The European Parliament and of The Council of 11 May 2011 setting	The ex-post evaluation of these regulations7 showed that they were effective in reducing CO2 emissions from new cars and light commercial vehicles. Thus, they are likely to have enabled between 65%-85% of the reductions in car exhaust emissions achieved after their introduction, also playing an important role in accelerating the reduction in emissions from light commercial vehicles. In addition, the regulations were more effective in reducing CO2 emissions than the voluntary agreements between the car industry and the European Commission in force between 1998 and 2009, and were more cost-effective than expected in achieving the targets set. However, these regulations only set emission targets until 2021 for passenger cars and until 2020 for commercial vehicles, and therefore did not provide sufficient incentives to further reduce vehicle emissions at the rate necessary to achieve EU climate targets, in particular to invest in alternative propulsion systems8, so in January 2020 a new regulation (Regulation (EU) 2019/631) entered into force setting new CO2 emission targets for new passenger cars and light commercial vehicles applicable from 2020, 2025 and 2030. Thus, for the period of 2020-2024, a target of 95 g of CO2/km is set as the average CO2 emissions of new passenger cars in the EU, and a target of 147 g of CO2/km as the average emissions of new light commercial vehicles registered in the EU. These targets consider the NEDC emission measurement procedure for 2020, based on the new WLTP procedure from 2021. From 2025 onwards, an EU fleet-wide target is set for average fleet emissions of both new passenger cars and new light commercial vehicles	https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A32009R0443 https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:145:0001:0018:en:PDF

[7] EC (2015). Evaluation of regulations 443/2009 and 510/2011 on CO_2 emissions from light-duty vehicles. Final Report. https://op.europa.eu/en/publication-detail/-/publication/7d6365fe-286c-4a6a-840c-877d79143022

[8] EC (2017). Commission staff working document. Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council setting emission performance standards for new passenger cars and for new light commercial vehicles as part of the Union's integrated approach to reduce CO_2 emissions from light-duty vehicles and amending Regulation (EC) No 715/2007 (recast). SWD (2017) 650 final.

	emission performance standards for new light commercial vehicles as part of the Union's integrated approach to reduce CO2 emissions from light-duty vehicles	equal to a 15% reduction of the 2021 target; while from 2030 onwards the target rises to a reduction, compared to the 2021 target, of 37.5% for passenger cars and 31% for light commercial vehicles. In 2021, as part of the 'Fit for 55' package, the Commission presented a proposal to revise Regulation (EU) 2019/631, setting more ambitious standards9. This proposal includes an increase of the emission reduction targets for the EU car fleet in 2030 to 55% for new passenger cars and 50% for new light commercial vehicles, compared to the 2021 target. In addition, a target of 100% reduction of the 2021 target is set for both passenger cars and light commercial vehicles from 2035 onwards. In February 2023 the European Parliament approved these new standards10.	
5.	Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (Text with EEA relevance)	The 2015 midterm review of the implementation of the Directive explicitly recommends the following: "not to make any changes to the RED provisions before 2020. As this midterm review concludes that overall, the RED proves to be effective and efficient, it can be considered to be best to maintain policy stability, which is key to investor security and therefore to both meeting the 2020 targets and future efficient RES growth. As an exception to the rule, in order to facilitate meeting the 10% transport target in 2020 effectively and efficiently, the indirect land use change (ILUC) proposal related to Art. 19.6 should be decided on as quickly as possible. A number of provisions could benefit from additional guidelines from the Commission, see the more detailed recommendations in the following paragraph."11 The review also recommends: "Furthermore, the study recommends to decide on the longer term framework for RES regulation in the EU well before 2020, to provide clarity on market outlook and continuation of the current RED provisions beyond 2020. This would ensure a seamless and efficient transition from the 2020 to the 2030 policy package, which will strengthen the current regulation and measures and encourage investments in RES throughout the EU."12 To make the transition of the energy and transportation sector to clean, sustainable and affordable forms of energy requires overcoming many obstacles. These relate to raising public awareness of the need to make the change and its benefits. They should address social, environmental and economic issues. Public and political support is a key prerequisite for effective RES policies and their implementation at the Member State level. The most significant provision of the Directive, which made the greatest contribution to boosting the development of renewable energy, was the introduction of mandatory targets and national renewable energy action plans, which were properly monitored through an indicative target trajectory for the 2010-2020 period and the submission of biennial progress reports.13	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2009.140.01.0016.01.ENG&toc=OJ%3AL%3A2009%3A140%3ATOC

[9] Regulation (EU) 2019/631. COM(2021) 556 final.

[10] European Parliament (2023). Fit for 55: zero CO_2 emissions for new cars and vans in 2035. https://www.europarl.europa.eu/news/en/press-room/20230210IPR74715/fit-for-55-zero-Co2-emissions-for-new-cars-and-vans-in-2035

[11] CE Delft, (2015), Ecologic Institute, Ricardo-AEA, REKK, E-Bridge: Mid-term evaluation of the Renewable Energy Directive. A study in the context of the REFIT programme. Delft, CE Delft, April.

[12] CE Delft … *op. cit.*

[13] Roldan I.A. (2019). *The renewable energy directive and its contribution to the deployment of renewable energy in the EU beyond 2020.* CEI International Affairs Escuela Diplomática de Barcelona

		According to the European Environment Agency: "Over the past two decades, renewable energy consumption has increased rapidly throughout Europe in response to dedicated policies and measures, and falling costs. Had the EU's renewable energy share not grown since 2005, it would have been necessary to burn a significant amount of fossil fuels to meet energy needs. In this case, EU greenhouse gas emissions would have been 11 % higher in 2018, jeopardizing the achievement of EU climate mitigation targets."14 The Directive on the Promotion of the Use of Energy from Renewable Sources succeeded in creating a favourable and certain legal framework that encouraged investment in renewable energy and allowed Member States to implement their own national solutions. The European Union's directives to promote and implement renewable energy sources in the energy mix have not been as successful as expected. Countries that have a very well-established political vision for the energy sector and political readiness have a good track record when it comes to implementing. This has created considerable certainty among investors and resulted in many RES projects and lower costs. Facilitating access to the grid for new entrants has contributed to the development of this energy industry. However, the implementation of the Directive was in the hands of the Member States, which used different instruments and supported electricity generation first and heating, cooling or transport to a lesser extent renewables in their energy mix.15 After the implementation of the Directive, important issues emerged that needed to be resolved at the regional level: simplification and harmonization of administrative procedures through one-stop-shop regulation of prosumers and civic communities, which has been the subject of discrimination in some Member States, as well as grid interconnection and grid modernization. Attention is also drawn to the need to increase competition and market integration of renewable electricity through tendering processes, accelerate the uptake of renewables in the heating and cooling and transportation sectors through voluntary targets, strengthen the sustainability of bioenergy, phase out biofuels based on food crops, and provide investors with long-term certainty through a mandatory target at the EU level. The use of renewable energy should not be at the expense of biodiversity, efficient use of resources must be aligned with continuous improvements in energy efficiency, and so on. Such a comprehensive change will require an increasingly integrated and systemic approach.16 Introduce more binding measures for renewable heating and cooling, which, in addition to implementing efficiency policies, would encourage greater use of renewable electricity, geothermal and solar heating, facilitated by heat storage and district heating systems. The development of renewable energy in the EU serves not only as a tool to reduce dependence on fossil fuels or with climate change. It was also the starting point for integration into Europe's internal energy market under the governance of the Energy Union. The use of renewable energy should not come at the expense of biodiversity, efficient use of resources must be aligned with continuous improvements in energy efficiency, and so on. Such a comprehensive change will require an increasingly integrated and systemic approach.	

[14] https://www.eea.europa.eu/themes/energy/renewable-energy/renewable-energy-in-europe-key

[15] Roldan I.A …*op. cit.*

[16] Roldan I.A. …*op. cit.*

		Specific targets proposed for the use of renewable energy in transportation, heating and cooling, buildings and industry, with increasing emphasis on moving away from classic renewable energy sources (e.g., solar and wind power) to new types of energy (e.g., hydrogen, biofuels and other renewable fuels). Biomass, especially the use of wood, should not be supported by the European Commission. To support the deployment of renewables, Member States should remove barriers in permitting procedures and power purchase agreements, and develop work on guarantees of origin. Taken together, the recast of the EED and the revision of the RED are aimed at increasing the share of renewables in the energy mix and achieving increased energy efficiency targets through integrated energy systems.	
6.	Directive 98/70/EC of the European Parliament and of the Council of 13 October 1998 relating to the quality of petrol and diesel fuels and amending Council Directive 93/12/EEC Directive 2009/30/Ec Of The European Parliament And Of The Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland	This Directive was effective in creating the necessary conditions for the development of markets for biofuels and other fuels with lower greenhouse gas emissions intensity. However, in the view of stakeholders, the Directive has not yet contributed to the expected social and environmental impacts and has not given a new impetus to the technological development of more efficient engines. Factors hindering the achievement of the targets include the inconsistency of the regulatory framework (mainly due to inconsistency with the Renewable Energy Directive) and the low expected return on investments made by suppliers/producers to reduce GHG emission intensity. In addition, the lack of national support schemes is another barrier to investments, while other difficulties include the insufficient availability of sustainable feedstocks and the lack of harmonisation of national transpositions and blending obligations in those MS that have chosen to introduce them in their national legislation. This reduces both supply and demand for fuels with lower GHG emission intensity and therefore slows down their uptake and the achievement of the Directive's targets17. In 2018, the vast majority of the EU Member States were below their mandatory 2020 target of a 6% reduction in lifecycle GHG emissions intensity and the indicative 2017 target of a 4% reduction relative to 2010 levels. Thus, on average for the EU, GHG emissions intensity had been reduced by 3.7% compared to 2010, and only two EU Member States (Finland and Sweden) had reached the 2020 target, while three others (France, the Netherlands and Poland) had reached the indicative target for 2017. Within the countries that had not reached the 2020 target, the distance to the target ranged from 1.4% in Poland to 5.9% in Croatia18.	https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A31998L0070 https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0088:0113:EN:PDF

[17] Lo Piparo, L., Chicot, J., Markianidou, P., Le Gallou, M., Kveiborg, O., Wahler, L., Skolina, J., Goumas, T., Vourliotakis, G. (2021). Support study on the evaluation of article 7ª of the fuel quality directive and assessment of approaches to reduce greenhouse gas emissions from transport fuels. Final report.
[18] Lo Piparo … *op. cit.*

	waterway vessels and repealing Directive 93/12/EEC		
7.	Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure	This Directive, in combination with other legislative initiatives, has had a considerable impact on both the uptake of alternative fuel vehicles and their infrastructure. Thus the share of sales of alternative fuel vehicles in 2020 is slightly higher with the Directive than in a scenario without the Directive, and this positive effect will increase significantly towards 2030. It has also had a direct impact on the number of electric charging points, which is expected to be about twelve times higher in 2030 than without the Directive, and a similar impact is expected for LNG and hydrogen refuelling points. However, investments in alternative fuels infrastructure in ports have been limited in most Member States. Finally, the Directive has had a considerable effect on the interoperability of alternative fuels infrastructure, although a number of shortcomings still prevail that could hamper the smooth movement of users across borders, especially with electric vehicles19. As part of the "Fit for 55" package, the European Commission proposed in 202120 to repeal the Directive and replace it with a Regulation to ensure a rapid and coherent development of the infrastructure network across the EU. This regulation sets a series of mandatory national targets for the deployment of alternative fuel infrastructure in the EU for on-road vehicles, boats and stationary aircraft, requiring Member States to expand charging capacity in line with sales of zero emission cars, and to install charging and refuelling points at regular intervals on major motorways.	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32014L0094
8.	Directive 2012/27/EU of the European Parliament and of The Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC	Puts in place several important provisions to be implemented by MS including the requirement to establish binding national energy efficiency targets, national building energy efficiency strategies, a requirement to renovate 3% of public sector buildings each year, the need to establish energy efficiency obligation schemes and provisions for auditing and metering. The Directive requires MS to implement Energy Efficiency Obligations and/or alternative policy instruments in order to reach a reduction in final energy use of 1.5% per year. The Directive rather than stimulating new technologies, it has rather provided minimum energy efficiency standards and labeling for a variety of products. The EED requires Member States to introduce national guiding plans that set the standards for governing energy efficiency locally. However, there is a huge variation of including policy measures in the national plans. Thus, the contribution to improving energy efficiency at the EU level may be unevenly distributed across Member States. The national obligation schemes that are requested in the Energy Efficiency Directive are considered as a right step that fosters the market for energy efficiency. However, the barrier that was the most often highlighted is the fact that the timeframe has made it difficult to attract investment in a long term.	https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:315:0001:0056:en:PDF#:~:text=This%20Directive%20establishes%20a%20common,efficiency%20improvements%20beyond%20that%20date.

[19] European Commission. (2021). Report on the application of Directive 2014/94/EU on the deployment of alternative fuels infrastructure. COM(2021) 103 final.
[20] European Commission. (2021). Proposal for a regulation of the European Parliament and of the Council on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU. COM(2021) 559 final.

		The transport sector is not the highest priority sector for national policies on energy efficiency in relation to the EED. Most Member States, following the implementation of the EED focused on implementing measures that are a burden for consumers rather than the industry. Revised version of EED is a part of The Clear Energy for All Europeans package (CEP) and thus its measures are complementary to the EPBD in terms of creating requirements for heat systems in particular in the building sector.	
9.	Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products	The Directive establishes a framework to set mandatory energy performance requirements for energy-using and energy-related products. The Directive covers more than 47 product groups (such as heating systems, lightbulbs, white and brown goods, motors, etc.) and the minimum standards are constantly being amended as the market average in terms of energy efficiency improves over time. The Directive remains relevant as it remains responsive to the needs and ambitions of its time and can be defined as a first step towards more comprehensive action related to a circular economy. While it puts weigh on responsibility on manufacturers and importers to comply with harmonised standards, potential penalties depends on national regulations. From the perspective of innovation, the Directive advances the objective of improving the energy efficiency of energy-related products but takes place through the diffusion of existing technologies rather than creating new ones. In addition, the Directive does not adjust to potential technological changes and thus some requirements have quickly became outdated. The Directive encourage the Commission to support SME in integrating environmental aspects including energy efficiency when designing their products. However, at the moment when the Directive came into power, the costs of adjusting to the environmental aspects of Ecodesign had opposite effect on investing in low-carbon solutions. Moreover, the Directive excludes transport sector from its scope. Therefore, it does not have a direct impact on this aspect of infrastructure. Except fostering the circular economy in the EU, the Directive is also an important intervention in the global context. The Directive can contribute to various actions that may lead to the harmonization of product specifications between the EU and other important manufacture-based economies.	https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32009L0125
10.	Directive 2010/31/EU of the European Parliament and 0f the Council of 19 May 2010 on the energy performance of buildings Directive (EU) 2018/844 of the	The EPBD is not setting EU-wide standards because of the variation of building types, climate, and construction techniques across the whole EU. Instead, it requires each Member State to set its national building standards by calculating cost-optimal minimum energy performance requirements for new as well as renovated buildings. In terms of innovation, the EPBD introduces higher degree of digitalization and encourages to integrate renewables to smart grids and smart-ready buildings. The Directive lacks attractive instruments that could improve investment in building renovations. On the other hand, national certification schemes have been considered as a useful tools that encourage consumers to buy or rent more energy-efficient buildings and on sending a demand-driven market signal.	https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0013:0035:en:PDF https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2018.156.01.0075.01.ENG

	European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency (Text with EEA relevance) – named EPBD	In terms of electro-mobility, the Energy Performance of Buildings Directive requires car parks of non-residential buildings to be equipped with at least one recharging point, and in new substantially renovated buildings, all parking spaces should be equipped with ducting infrastructure. However, the renovation measures are only limited to the parking lot or the electric infrastructure of the building. The energy performance of buildings depends not only on energy savings but also on energy sources. Therefore, the EPBD is also linked to the Renewable Energy Directive and the Alternative Fuels Infrastructure Directive. Together with Ecodesign Directive, the EPBD has an impact on health aspects by fostering the usage better quality materials in the building sector. The EPBD is also associated with reducing the risk of energy poverty and creating a demand for new skills on the job market.	
11.	White Paper Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system	Since the publication of the White Paper, there has been much more talk about mobility and less about the transport sector. There is also more placing of this topic in general climate policy - this is indicated by the lack of a new edition of the White Paper, which should have been published in 2021. Instead, the document "Sustainable and Smart Mobility Strategy – putting European transport on track for the future" was published with the word 'transport' and 'white paper' missing from the title. It's a detail, but it shows the changing position of transport policy. The difference between 2011, when the White Paper was published, and now is that the focus then was on developing a resource-efficient and sustainable transport system. Now it is about ensuring sufficient mobility quality as one of the challenges of the EU climate and energy policy. Suffice it to say that climate objectives related to the decarbonisation of transport have been integrated into the framework of European climate policy (e.g. the European Green Deal and FitFor55), thus bringing transport policy under climate policy. The way the market of alternatively-fuelled vehicles looks today shows that the goals of the White Paper, although initially ambitious on the verge of being unrealistic in their implementation, have been successful. A similar assessment can be made of the importance that is now being placed on energy efficiency in transport. Previously, it was mainly to suggest that it was important. Now, on the other hand, it is a key issue – largely integrated also into the EU policy on the energy efficiency. The White Paper calls for infrastructure to be planned in a way that maximises the positive impact on economic growth and minimises the negative impact on the environment. It also highlights the East-West inequalities in Europe in terms of infrastructure. These inequalities are diminishing more rapidly in the area of road and air transport infrastructure than in the case of, for example, urban mobility behaviour or the standard of rail infrastructure. From a climate point of view, this is a very negative development that goes against the spirit of transport policy as expressed in the 2011 Transport White Paper.	https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex:52001DC0370
12.	The Common Agricultural Policy (CAP) is the EU's oldest policy, which was	The lack of complete and quantifiable information on the benefits of CAP climate action makes it difficult to assess effectiveness. Most CAP instruments were not intended to implement climate policy, but interacted with climate action as an indirect effect. Overall, the set of CAP instruments is only partially related to the needs of EU climate policy. Notably absent from the first pillar are measures to reduce emissions from livestock farming and the use of nitrogen fertilizers.	The assessment was based largely on "Evaluation study of the impact of the CAP on climate change and

	initiated in 1962 and continues today.	The CAP needs to take a completely new direction, promoting organic farming through national strategies that will cover the entire production and distribution chain, as well as through the targeted use of EU funds for agri-environmental and climate measures. In June 2018. The European Commission came out with a proposal to further support organic farming with area-based payments in the next budget period, thereby fulfilling the EU's environmental, climate and governance commitments. It was left up to the Member States to decide whether and how to promote organic farming.21 In the evaluation material impact of the Common Agricultural Policy on climate change and greenhouse gas emissions the following conclusions were made. "Based on a thorough analysis of needs, the targeting of climate mitigation and adaptation in Member States' rural development programmes could be improved and better monitored. The mitigation and adaptation potential of several CAP measures could increase if:22 ploughed grassland would not be classified as 'permanent grassland'; the ban on ploughing permanent grassland (currently for environmentally sensitive permanent grasslands) would be extended to more areas; small farmers would not be exempted from climate-relevant requirements under current greening; fallow land would always be covered; protection and restoration of wetlands and peatlands would be enhanced; the level of ambition of CAP instruments/measures would increase; aid for areas facing natural or other specific constraints would be subject to land management requirements; coupled support for livestock would be targeted at extensive systems; support would be screened to avoid poor adaptation (e.g. irrigation support in areas in risk of water depletion). The dissemination of knowledge and improved advice to farmers on techniques and practices which can improve climate performance (both mitigation and adaptation) can be improved." The key, from the perspective of greenhouse gas emissions of carbon sequestration, is to see the CAP not only in relation to local agricultural systems within the EU but its implications for emissions or sequestration that occur elsewhere. Examples include the transportation of agricultural and livestock products, their processing or the production of feed or fertilizer. Consumption of animal products is a major contributor to greenhouse gas emissions in the agricultural sector. Reducing caloric intake in accordance with WHO guidelines and reducing protein intake in meat would lead to reduced agricultural GHG emissions and public health benefits. This would need to be combined with efficiency measures to address issues such as food waste, which are linked to the development of the bioeconomy, and broader consideration of the environmental, economic and social importance of certain livestock production systems and their impact on the structure of the agricultural sector in the EU. CAP instruments offer limited opportunities to address consumption patterns other than indirectly through, for example, product development and marketing. Dietary choices have a major impact on production	greenhouse gas emissions" Final Report. European Commission. 2018.

[21] ATLAS ROLNY (2019) – Dokąd zmierza europejska wspólna polityka rolna? Fundacja Heinricha Boell'a w Polsce, Fundacja Instytut na rzecz Ekorozwoju. Warszawa.

[22] COMMISSION STAFF WORKING DOCUMENT EVALUATION of the impact of the Common Agricultural Policy on climate change and greenhouse gas emissions {SWD(2021) 116 final}Brussels, 21.5.2021 SWD(2021) 115 final.

		decisions and resulting greenhouse gas emissions. Strengthening the link between agricultural production and the goal of promoting healthy diets could help with regard to the sectors that currently emit the most GHGs in agriculture (livestock and farmland management emissions). Livestock systems based on locally produced feed could lead to a 4.5% to 12% reduction in GHG emissions. Currently, there is significant dependence on non-EU markets (and thus insecurity) for commodities such as soybean meal, 95% of which is imported. It is important to fully recognize not only the need to reduce our own greenhouse gas emissions from agriculture and forestry, but also to play an important role in achieving other goals, for example by providing space for renewable energy infrastructure such as photovoltaics or wind turbines, the production or collection of waste and residues for energy production, or the provision of biomass for energy and transport biofuels.	
13.	Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions Closing the loop - An EU action plan for the Circular Economy	As written in the CEAP Implementation Report presented by the European Commission in 2019, implementation of the Action Plan has accelerated the transition to a circular economy in the EU. A stronger, shared vision for a circular economy can only strengthen ongoing efforts to modernize the EU's industrial base to ensure its global competitive advantage and protect and restore the EU's natural capital. These elements and successful efforts can help and guide the future work of European institutions, Member States, businesses and social partners.23 The Circular Economy Action Plan fits in part with climate policy, reinforcing it and in many sectors contributing to energy conservation and efficiency improvements, or shifting away from fossil fuels to renewable energy as a result of the development of the bioeconomy, with the consequent reduction or avoidance of greenhouse gas emissions. However, it lacks direct climate targets. The transition to a circular-loop economy partly fits into the long-term strategic vision of a prosperous, modern, competitive and climate-neutral economy by 2050. The promotion of new business models based on circularity, recycling, energy and material efficiency or new consumption formulas have significant potential to reduce greenhouse gas emissions. According to Eurostat, the number of jobs related to circular economy activities increased by 6% in the EU between 2012 and 2016. The action plan also encouraged at least 14 Member States, eight regions and 11 cities to present circular economy strategies.24 However, it is noticeable that the limited scope of this Plan's approach focused on the technocratic side of resource management without the use of many instruments for treating the circular economy holistically. It is essential to address, strongly rather than softly, the economy in a broader way that takes into account the shift away from its linear dimension and changes in consumption behaviour. A shift like this would affect a stronger integration of the circular economy with climate policy.	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52015DC0614

[23] REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS on the implementation of the Circular Economy Action Plan. Brussels, 4.3.2019 COM(2019) 190 final, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52019DC0190&from=EN

[24] https://ellenmacarthurfoundation.org/circular-examples/the-eus-circular-economy-action-plan

		Also important, according to the WHO study, is an understanding of the health effects of the transition to a circular economy - especially with regard to chemicals of concern, water reuse, electrical and electronic waste, and distributional impacts shows significant gaps. Further research and evidence is needed to enable a more complete assessment of policy priorities for addressing negative impacts and enhancing positive ones.25	
14.	Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan {SEC(2008) 2110} {SEC(2008) 2111}	The Plan is part of a worldwide push to increase resource efficiency and efforts to become more sustainable, becoming an important source of innovation and an important factor in boosting industrial competitiveness. It complements existing policies on energy use, particularly the energy and climate package adopted by the Commission in January 2008. Innovation in the area of environmental goods and services is very important for the successful implementation of the Plan and plays a key role in innovation policy. One of the available indicators for measuring the level of innovation is the number of patents in a given field. According to the OECD, the number of patents related to environmental innovation in the EU is increasing, with the leading Member States granting 3.5 patents per billion GDP (in euros) annually. It should be noted that EU policy consumer information has focused on the energy efficiency of household and office appliances under the Energy Labeling Directive and the Energy Star programme but has covered only a limited number of products. Finally, activities at the individual Member States level are often not coordinated. Existing financial support for implementing solutions toward sustainability also needs to be reconsidered - a robust and targeted policy on Sustainable Consumption and Production is needed to serve more climate protection in line with the Paris Agreement. The transformation toward sustainability and determining the state of a process or system from its perspective requires a concept that goes beyond GDP. It is essential to develop indicators that are as clear and attractive as GDP, but that take greater account of the environmental, social and political aspects of global progress.10	https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A52008DC0397

[25] Circular Economy and Health: Opportunities and Risks. World Health Organization (2018) https://www.euro.who.int/__data/assets/pdf_file/0004/374917/Circular-Economy_EN_WHO_web_august-2018.pdf

Appendix B The questionnaries for the survey on the EU climate policies' assessment (2005-2010)

Below there are available links to the questionnaires prepared for the survey design. The questionnaires are also stored by the WiseEuropa Institute.

- Innovation: https://www.surveymonkey.com/r/4i_innovation
- Investment: https://www.surveymonkey.com/r/4i_investment
- Infrastructure: https://www.surveymonkey.com/r/4i_infrastructure
- Integration: https://www.surveymonkey.com/r/4i_integration

Appendix C Summary of in-depth qualitative interviews with EU climate policy experts

The table below lists, in alphabetical order, 13 individuals who participated in the in-depth qualitative interviews. The subsequent tables are anonymized and do not necessarily appear in this order.

No.	Name	Surname	Affiliation	Country
1.	Bart	Istvan	Previously DG Clima, Institute for Climate Strategy 2050	Hungary
2.	Sander	de Bruyn	Netherlands Environmental Assessment Agency	The Netherlands
3.	Tomáš Jungwirth	Březovský	Head of the Climate Team, Association for International Affair	Czechia
4.	Jos	Delbeke	formed Director General DG Clima, University Florence	Netherlands
5.	Ibon	Galarraga	Professor BC3 Basque Centre for Climate Change	Spain
6.	Magdalena	Garcia Mora	Head of Climate Change Acciona Energy	Spain
7.	Luis- Gaetan	Giraudet	Research Fellow, International Center for Research on Environment and Development	France
8.	Robert	Jeszke	The National Centre for Emissions Management, Project coordinator of Centre for Climate and Energy Analysis	Poland
9.	Marcin	Korolec	Formed Polish Minister of Environment, Director of the Green Economy Institute	Poland
10.	Bert	Metz	Dutch climate policy expert, Former IPCC Working Group Co-Chair	The Netherlands
11.	Michael	Pahle	Working Group Leader, Postsdam Institute for Climate Impact Research	Germany
12.	Wendel	Trio	Formed director Climate Action Network Europe, independent expert	Belgium
13.	Janusz	Turski	Polish Pulp and Paper Industry Association	Poland

<table>
<tr><td colspan="3">Person 1</td><td>Who conducted the interview:
Pol Fontanet Perez</td></tr>
<tr><td colspan="4">Whether during policy formulation policymakers have exhausted all potential instruments to meet headline climate goals. If not, was possible to formulate a policy to be more effective?</td></tr>
<tr><td>Assessment of the instruments

• Related to policies of buildings energy efficiency in France: Diversity of instruments but with limitations: Tax rebates, subsidies for retrofit works etc.</td><td colspan="2">Assessment of policy effectiveness

• On the positive side, targeting lower income population is somewhat of a double dividend because on the one hand you reduce fuel poverty, but you also target the building that are most inefficient. Because there's a correlation, unfortunately, between the energy performance of a dwelling and the income of the occupant. And so if you so target the most inefficient dwelling, then this is where investments saves the most energy. So it's a wise use of public money. I mean the cost effectiveness is higher and on the other hand you reduce food poverty so. So this is good, targeting is good but sometimes it can be at the expense of the simplicity of the program because when you when you start having many different categories</td><td>Others

n/a</td></tr>
<tr><td colspan="4">Whether some gaps or barriers have appeared during the implementation of discussed policies. What challenges have been observed during their implementation?</td></tr>
<tr><td>Gaps

n/a</td><td>Barriers

• The complexity of the instruments has created a lot of complication and if this scheme is not easy to fathom for the prospective candidates, then it can be, not acceptable because of that. And on top of that, the bureaucracy is quite significant. The delays are significant too. So that this may discourage a lot of households to apply.</td><td>Challenges

• The problem is most actions taken are really simple renovations, not comprehensive retrofits, so that's also a concern. It doesn't manage to tackle and induce comprehensive retrofits which would have a larger impact on energy efficiency.
• Net zero in the building sector and energy efficiency ambitious targets is such a daunting task that it cannot be expected that public money will not do it alone. So we need also private money. But in this case this is private money but ultimately paid by paid for by households in in their energy bills</td><td>Others

n/a</td></tr>
<tr><td colspan="4">What implication can be drawn from the period 2005-2020 (in terms of ambitions, complementarity, and implementation) for a better formulation of climate policies in the future?</td></tr>
<tr><td>Ambitions</td><td>Complementarity</td><td>Implementation</td><td>Others</td></tr>
</table>

Person 1			Who conducted the interview: Pol Fontanet Perez
• So my assessment of the current situation is that we provide relatively little money and that is scattered in different programs and so I feel like we need some consolidation and we need like much more money. If we manage to leverage much more money, we can be more ambitious in the type of actions and leverage and encourage more comprehensive retrofits.	n/a	n/a	• And As for the European Union directive, so I feel like the white certificate program was inspired by EU legislation. But when it was implemented, only the UK and Italy had such a program. I think now there are many more countries across Europe having one, but still the French one is probably the biggest one. But I feel like the, let's say the European impetus only played a marginal role in it.
Considering challenges that have identified in the EU climate policies during 2005-2020, how can the multi-crisis (pandemic, war, energy, and economic crisis) contribute to the transformative change of the EU climate policies in the future?			
Challenges	Transformative changes	Others	
n/a	n/a	n/a	
Final observation			
• Energy efficiency instruments in the building sector in France have only been partially successful. A more coherent policy mix is necessary. Also, more resources would allow for more impact. Nonetheless, there has been a good learning experience and some modifications have been made to improve shortcomings. The experience in France can be valuable for other Member States with less advanced policies.			

Person 2			Who conducted the interview: Pol Fontanet Perez
Whether during policy formulation policymakers have exhausted all potential instruments to meet headline climate goals. If not, was possible to formulate a policy to be more effective?			
Assessment of the instruments	Assessment of policy effectiveness	Others	
• The instruments are appropriate, the problem has been more related to the specific design and the implementation of the selected of instruments.	n/a	• Sometimes a single instrument has been used to try to achieve more than one objective. This doesn't usually work because we have studied it many times in the faculty, but then we forget it when it comes to designing public policy. On the other hand, what also happens is that many of the instruments that are designed are not really well designed for the objective that is being pursued, for example, in the case of subsidies for energy efficiency.	

<table>
<tr><td colspan="3">Person 2</td><td>Who conducted the interview:
Pol Fontanet Perez</td></tr>
<tr><td colspan="4">Whether some gaps or barriers have appeared during the implementation of discussed policies. What challenges have been observed during their implementation?</td></tr>
<tr><td>Gaps

• Some policies that are supposed to stimulate change sin behavior are designed in a way that only incentivises those who already would have the capacity to invest in newer technologies. For example in subsidies for electric cars.</td><td>Barriers

• Sometimes political negotiations make that the final design of the instruments is not the same as the one prescribed at the technical level. This creates some inefficiencies and limitations during the implementation fo the projects.</td><td>Challenges

n/a</td><td>Others

• The EU ETS has been successful in the sense that the whole structure of a EU-wide emissions trading market has been created. However, it has been underutilized partially due to the inability to achieve higher Carbon prices.</td></tr>
<tr><td colspan="4">What implication can be drawn from the period 2005-2020 (in terms of ambitions, complementarity, and implementation) for a better formulation of climate policies in the future?</td></tr>
<tr><td>Ambitions

• There needs to be a balance between ambition and acceptability. Gaining acceptability from the private sector was taken into account in the 2005-2020 period. Now it is important also to gain citizens' acceptability towards new policies. This requires good communication.</td><td>Complementarity

• There is still some inconsistencies among different policies. Sometimes they promote contradictory goals that create inefficiencies.
• There needs to be a global vision of the whole climate policy and its role within the rest of policies to find a coherent policy mix.</td><td>Implementation</td><td>Others

• There needs to be enhanced measures that correct the distributional effects of some of the climate policies.</td></tr>
<tr><td colspan="4">Considering challenges that have identified in the EU climate policies during 2005-2020, how can the multi-crisis (pandemic, war, energy, and economic crisis) contribute to the transformative change of the EU climate policies in the future?</td></tr>
<tr><td colspan="2">Challenges

• Crisis and external effects are recurrent. It is not possible to predict them specifically, but it needs to be taken into account that some unexpected events can happen so to take that into consideration in the policy design.</td><td>Transformative changes

• To achieve transformative policies, a global perspective is necessary on governance that takes into account the acceptability of all sectors and specifically of citizens.</td><td>Others</td></tr>
<tr><td colspan="4">Final observation</td></tr>
</table>

Person 2	Who conducted the interview: Pol Fontanet Perez
• The main problems are not related to the instrument selection but to the final design, which has often been conditioned by the need to reach political consensus. Acceptability of policies and higher participation by citizens is necessary to be able to formulate and implement more stringent and transformative policies.	

Person 3	Who conducted the interview: Andrzej Kassenberg

Whether during policy formulation policymakers have exhausted all potential instruments to meet headline climate goals. If not, was possible to formulate a policy to be more effective?

Assessment of the instruments	Assessment of policy effectiveness	Others
• Many instruments were introduced, but ambitions were relatively moderate. • The main pillars were renewables and energy efficiency, and later the EU ETS. • The construction sector was poorly utilised - it is necessary to make wise policies and take more into account the living situation, other social circumstances and we simply need better data in the construction sector.	• The years between 2015 and 2017 were largely an experimental period in which much was learned. • In the early stages, it is better to have a member state-specific target and as the situation stabilises it should be done as part of a more EU-wide approach. • In recent decades, we've seen a lot of energy efficiency in sectors because the pressure for energy efficiency comes from competition.	• It was done step by step and see how it would go and then take the next step. • Each country is in a different situation, but there is still a logic of using individual countries or goals for individual countries when it comes to sharing the effort or burden. • We are now at a turning point where a new orientation is developing.

Whether some gaps or barriers have appeared during the implementation of discussed policies. What challenges have been observed during their implementation?

Gaps	Barriers	Challenges	Others
• We've come pretty far with renewables, we've come fundamentally far with the EU ETS, and we've gotten nowhere with agricultural policy. • Failure to see organizational and social innovation.	• The main barrier, were and are the household sector or society as a whole. • It was not possible to engage in breaking down the barriers of all interest groups, one was chosen to solve the problem and another and so on.	• A major challenge has been to distinguish between companies and industry and households. So at least prospects for new business models are needed. • Sectors are interconnected in Europe, and this is linked to international trade. E.g. There are interconnections between energy and social policy and agriculture.	• Climate policy is now reaching households and there is a perception there that it is too costly. We need to scale down in terms of ambition. • At some point we have to address all problems at the same time and that is, difficult.

Person 3			Who conducted the interview: Andrzej Kassenberg
What implication can be drawn from the period 2005-2020 (in terms of ambitions, complementarity, and implementation) for a better formulation of climate policies in the future?			
Ambitions	Complementarity	Implementation	Others
• There is a lot of technological progress and, also some social progress.	• Aspect of integration is extremely important, especially since it is not yet really managed.	• We need a major social contract in the context of climate policy.	• It's no longer about the energy transition but the climate goal is crucial. • We need to learn from the past on how to deal with the new geopolitical situation.
Considering challenges that have identified in the EU climate policies during 2005-2020, how can the multi-crisis (pandemic, war, energy, and economic crisis) contribute to the transformative change of the EU climate policies in the future?			
Challenges	Transformative changes		Others
• Climate is important, but other crises, other aspects or goals are equally important. • We need to reconsider the policies we have used in the past and think about how to conduct climate policy so that it is widely acceptable - a social priority.	• How to embed European climate policy in the international sphere and play an active role in it. • Now the markets are joining in and making demands on climate policy which makes it a whole different game now – mobilizing innovation and finance. We just need to make sure we lead them in the right direction.		• There is now a kind of race towards net-zero technologies, so in that respect we should be satisfied. • Climate policy is politicised and orchestrated by some and we need more involvement of people, more awareness and understanding of the problem - there is a need to inform and perhaps educate. • The most pressing challenges require a generational change.
Final observation			
• Stronger integration of policies is becoming key, as well as the fundamental inclusion of societies in the creation and implementation of climate policy, and it is clear that markets and business are increasingly demanding stronger incentives and support.			

Person 4		Who conducted the interview: Pol Fontanet Pérez
Whether during policy formulation policymakers have exhausted all potential instruments to meet headline climate goals. If not, was possible to formulate a policy to be more effective?		
Assessment of the instruments	Assessment of policy effectiveness	Others
		n/a

<table>
<tr><td colspan="3">Person 4</td><td>Who conducted the interview:
Pol Fontanet Pérez</td></tr>
<tr><td colspan="2">• In the first place we think that those targets are not enough, and we are pleased that more stringent targets (and derived policies) are considered.</td><td colspan="2">• The challenges that may arise and must be faced considering that Climate Change, which is accelerating, are on the one hand, related to Speed: An structural problem the EU has is, when there is the need of changing policies and make them effective, that the time it needs to do so is too long. Anyway, circumstances have not been easy lately, and it is true that the EU is moving faster than usual
• In any case, the challenges we find we face in this respect are:
○ policies‘ objectives were not enough and there are long times to build up new policies
○ long times to adopt policies
○ and the deadlines to start implementing them as well</td></tr>
<tr><td colspan="4">Whether some gaps or barriers have appeared during the implementation of discussed policies. What challenges have been observed during their implementation?</td></tr>
<tr><td>Gaps</td><td>Barriers</td><td>Challenges</td><td>Others</td></tr>
<tr><td>• The GAPS that would have to be filled and in 20 20 20 had not been considered: The future MUST necessarily be renewable, so innovation and integration are essential to make it possible: we must continue working with policies and technological development in, for example, STORAGE, HYDROGEN and DLR
• Looking at lacking policies, like those related to transport and circularity might be essential
• Didn’t find the key to increase Energy Efficiency: that is a main challenge, not achieved yet
• Another key issue to work further is integration: we must lead to a renewable and electric future. To do so: Pushing policies for implementation in Storage, Hydrogen, the need to develop all the resources for optimizing the (efficient) use of electrical infrastructures, among which is the Dynamic line rating (DLR), as tools to solve the integration problem. Incentives to create scale economies works: the decrease in price of PV and Wind proves it.</td><td>• We have been observing mainly barriers coming from two fronts:
○ That the measures of European policies create a competitive disadvantage in European companies, and that international trade is affected
○ That the measures of European policies make the most vulnerable citizens suffer</td><td>n/a</td><td>n/a</td></tr>
<tr><td colspan="4">What implication can be drawn from the period 2005-2020 (in terms of ambitions, complementarity, and implementation) for a better formulation of climate policies in the future?</td></tr>
<tr><td>Ambitions</td><td>Complementarity</td><td>Implementation

n/a</td><td>Others

n/a</td></tr>
</table>

Person 4		Who conducted the interview: Pol Fontanet Pérez	
• The participation of Private Sector is essential if we want to improve in terms of ambition and implementation of climate policies. • Recently, it has been seen that the interest of citizens in climate change has increased, as well as that of companies, facilitating the joint push that is so needed. Accompanying this growing interest, imprecise communication about their performance by some companies has also been observed, which may spoil the effort of others. To avoid it, it is necessary to work the Transparency of companies: Reporting Sustainability Policies, are also essential	• Combination of policies work: Ban (prohibit) certain things, and incentivise others, works. • As first step ban on fossil fuels is a must. Careful about deadlines, not to establish them to far away, and start today using economic tools for the change		
Considering challenges that have identified in the EU climate policies during 2005-2020, how can the multi-crisis (pandemic, war, energy, and economic crisis) contribute to the transformative change of the EU climate policies in the future?			
Challenges	Transformative changes		Others
• Goal must be renewable, and distractions going into urgency for gas supply or even coal are not affordable in the current climate situation: urgency faces urgency • Also citizens should not look so much at the very short term: energy independence is a very interesting side effect, that would help avoiding another energy crisis in the terms we are facing it today, and that brings both comfort to citizens and security and competitiveness to private sector	n/a		n/a
Final observation			
• Policies should have been more ambitious from the beginning. Businesses must have a key role, but it is important that competitiveness aspects of EU businesses is taken into account. Also pay attention to distributional effect of the policies. In terms of energy, renewables need to be the priority, gas is a distraction we cannot afford.			

Person 5	Who conducted the interview: Andrzej Kassenberg

Whether during policy formulation policymakers have exhausted all potential instruments to meet headline climate goals. If not, was possible to formulate a policy to be more effective?

Assessment of the instruments	Assessment of policy effectiveness	Others
• Lack of a comprehensive outline of the overall climate policy architecture. • The introduction of the NER300 program was supposed to alleviate the high-cost situation, but it did not quite succeed because it was limited to CCS and only then RES technologies were included.	• The EU did not fully appreciate the problems for the new countries of the application of the EU ETS (e.g., the old countries did not have developed district heating on such a scale as in Poland). • In the initial phase of the EU ETS there were free allowances, and no funds were generated for transformation. • High costs of technological change or CO_2 capture with low entitlement prices.	• New EU countries entering in 2004 had to adapt to the EU ETS at a fast pace but reduce emissions of other pollutants in parallel. • Low efficiency of financial resources management in new countries; lack of experience and institutions. • Use of Kyoto mechanisms which distorted the allowance market.

Whether some gaps or barriers have appeared during the implementation of discussed policies. What challenges have been observed during their implementation?

Gaps	Barriers	Challenges	Others
• Not fully aligning the various instruments in time and scope to achieve synergies and causing them to overlap and compete with each other (improving efficiency or increasing the share of RES, lower emissions, lower allowance price, weaker impact on reduction).	• The structure of economies as well as energy exporters in need of significant restructuring, especially in new countries.	• The difficulty of reconciling ambition with the capacity of the different potential for reduction in individual EU countries, some of which have been in a period of power and economic transition. • Ensuring the necessary time to collect all the information and later distribute it to member states for verification there and for installations to calculate their allocations.	• Excessive speed in the preparation of the 3x20 package and then also its rapid implementation. • Insufficient preparation of detailed legislative solutions, e.g., delay in the designation of the most efficient technologies in the European Union, according to which the benchmarks were formulated.

What implication can be drawn from the period 2005-2020 (in terms of ambitions, complementarity, and implementation) for a better formulation of climate policies in the future?

Ambitions	Complementarity	Implementation	Others
• The entire architecture of climate policy in the Union for the 2040s will require deep structural reform.	• There needs to be a paradigm shift in climate-smart financing for food	• The restoration of peatlands, which are not essential for food	• Implementing the principle of solidarity in the formulation and

Person 5			Who conducted the interview: Andrzej Kassenberg
• One of the main challenges now will be to ensure public acceptance of the levels of ambition we will be drawing for the future beyond 2030. • Incorporating a circular economy as well as changes in social and consumer behavior is important but does not solve the whole vision of climate policy. • Clarity is more important, in terms of commitments, emissions, reductions than a series of different additional commitments/conditions.	production, but such a vision is lacking • Transportation was present in the 2005 - 2020 period but insufficiently requires much broader engagement.	production while not disrupting the EU's ability to feed itself, needs clarification. • It is better to use overall targets for the whole EU and not for individual countries, which gives more flexibility in implementation and allows to look for solutions with the lowest costs.	implementation of climate policy to evenly distribute efforts and costs • Without building climate neutrality in agriculture, there is no chance for an effective climate policy, although this is a huge challenge • Moving away from the strong politicization of the Common Agricultural Policy is one of the primary barriers. • Moving away from the dualism of EU regulations n e.g., on the one hand environmentally we would like to meet emission standards, and on the other hand we don't have the instruments to help people buy a new car that would meet higher emission standards.

Considering challenges that have identified in the EU climate policies during 2005-2020, how can the multi-crisis (pandemic, war, energy, and economic crisis) contribute to the transformative change of the EU climate policies in the future?

Challenges	Transformative change	Others
• In the first stage, the path to climate neutrality was outlined in the European Green Deal. However, COVID has proven to be a challenge. The question arises whether it will impede the process or perhaps only prolong it.	• The war in Ukraine and the energy crisis have accelerated the transformation of the European Union's economy. • Count on the use of hydrogen, with which we want to replace gas and in which the Union is pinning its hopes as the fuel of the future. The development of the hydrogen economy must be viewed through the prism of energy. • It becomes essential to see an important role for biogas in the transition.	• Climate policy is not implemented in such a way that some countries impose their vision on the grounds that it is in their economic interest. Climate policy to a common path to climate neutrality.

Final observation

- The main challenges for climate policy are to ensure solidarity in the distribution of responsibilities and finances by individual countries along with the full involvement of societies if we want to achieve ambitious goals on the road to climate neutrality.

Person 6	Who conducted the interview: Andrzej Kassenberg

Whether during policy formulation policymakers have exhausted all potential instruments to meet headline climate goals. If not, was possible to formulate a policy to be more effective?

Assessment of the instruments	Assessment of policy effectiveness	Others
• There was not enough consultation and information about the EU ETS in the new member states. • Basing the EU ETS on the top 10 benchmarks, which actually came from the old member states, was difficult for the new ones. • The legal basis for implementing the instruments was introduced too late.	• EU ETS as a market mechanism was overly strict and provided penalties for non-compliance. • Companies that were smarter and started earlier benefited from it. • In the new countries, implementation was easier if it involved industries with foreign capital better prepared to implement the policy.	• The introduced allowance trading scheme was somewhat of a surprise and a real novelty for the industry. • Carbon leakage was a threat. • Insufficient integration of climate policy with others. • Politicization of the process of negotiating the implementation of instruments undermined ambition.

Whether some gaps or barriers have appeared during the implementation of discussed policies. What challenges have been observed during their implementation?

Gaps	Barriers	Challenges	Others
• Difficulties for energy-intensive industries not fully recognised.	• For the banks, climate policy was new, and they were afraid to take on too much risk as they understood it.	• Greater use of economic incentives would be useful.	• Need to emphasise long-term solutions. • Perceived inadequacies were corrected EU also learned.

What implication can be drawn from the period 2005-2020 (in terms of ambitions, complementarity, and implementation) for a better formulation of climate policies in the future?

Ambitions	Complementarity	Implementation	Others
• More ambition is needed to decarbonize the economy.	• Introduce integrated solutions as part of the energy transition. • Increase in member countries the degree to which the funds obtained from trade are used to further reduce emissions.	• Maintain a carrot-and-stick approach.	• Strengthen information policy among both businesses and the public. • Limit the participation of speculative capital in the EU ETS.

Considering challenges that have identified in the EU climate policies during 2005-2020, how can the multi-crisis (pandemic, war, energy, and economic crisis) contribute to the transformative change of the EU climate policies in the future?

Challenges	Transformative changes	Others
• In a multi-crisis situation, the EU must take a leadership role in the energy and climate transition.	• Need to fundamentally strengthen climate education and information to raise awareness. • Empowerment of young people.	• Bring balance to climate diplomacy so that the needs of other countries, especially developing countries, are recognised.

Person 6		Who conducted the interview: Andrzej Kassenberg
• Resolve the problem of carbon leakage effectively. • Use artificial intelligence in the implementation of climate policy.		• Strongly engage churches around the world in climate transformation.
Final observation		
• It is important for the EU to maintain its leadership in paving the way for the energy-climate transition along with building the need to raise climate awareness within it.		

Person 7			Who conducted the interview: Krzysztof Krawiec
Whether during policy formulation policymakers have exhausted all potential instruments to meet headline climate goals. If not, was possible to formulate a policy to be more effective?			
Assessment of the instruments • EU ETS could have been a lot more effective • "We only witness now prices of above €100 which is broadly in line now the current prices is what you would expect from the market, but of course, and after this whole period 2005 to 2020, we had sub-optimal policies leading to much lower prices as predicted beforehand. And also much lower prices than would be in line with with the ambition of the of the of the climate policy" • A lot more provisions to prevent the enormous surplus in emission allowances	Assessment of policy effectiveness • All the proposals that came onto table before the final proposal came and they were a lot more ambitious • Technically policy could have been more ambitious .So they could intervene on the EU ETS for example, they could intervene on the 2020 targets • Politically, it was more difficult I think because Europe was less, you know, after the crisis, Europe was of course more divided (Greece, financial crisis)	Others • More ambitious policy was obviously possible • know the number of CO_2 in the end reduced was kind of obtained within the realms of the possibilities to use CDM credits for example to transfer CDM into EUA. So there were all kind of provisions created that yeah, if you don't believe the CDM, which I don't, then it was not a very effective policy. • Poland reluctant in 2007-2009 negotiations, but also Germany – Ministry of Environment replaced by the Ministry of Industry	
Whether some gaps or barriers have appeared during the implementation of discussed policies. What challenges have been observed during their implementation?			
Gaps • Buildings and built environment – 1st place, not so much exposed on or on the electricity sector • Agriculture - it possible to play it better, for example, including some	Barriers • Attitude of citizens – "so what are the top 10 problems you think climate change was not among them in those ages?"	Challenges • Strong lobbies of transport, industry, agriculture etc. In Brussels, acting against ambitious climate policies	Others • Electricity production obviously is the sector where most happened.

Person 7			Who conducted the interview: Krzysztof Krawiec
financial directives or maybe other instruments to address these sectors, because you mentioned that in terms of agriculture, nothing has been done within this period • Industry – not much has been done with is large emitter; • Transport, mobilty – no new transport policy since 2011 Very negative opinion on transport policy – including car industry involvment		• Competition with other countries (Turkey vs. Greece) • Electricity production and cars that was a very nasty policy for the confident that they made this the car manufacturers, so it had some impacts there	
What implication can be drawn from the period 2005-2020 (in terms of ambitions, complementarity, and implementation) for a better formulation of climate policies in the future?			
Ambitions • More ambitious policy for industry and agriculture – strong lobbies • Including aviation into emission allowances. • How to keep EU industry strong with climate protection (eg., carbon-free steel, green hydrogen)	Complementarity • Addressing financial directives of other instrument to address the sectors of industry or agriculture .	Implementation • Involvment of CBAMand agriculture .	Other • Reluctance of conservative agricultural-based parties • The role of EU diplomacy within the scope of CBAM • Right balance between European Commisno and countries
Considering challenges that have identified in the EU climate policies during 2005-2020, how can the multi-crisis (pandemic, war, energy, and economic crisis) contribute to the transformative change of the EU climate policies in the future?			
Challenges n/a	Transformative changes • A positive lesson from the EU reaction on COVID	Others • . Not the role of climate policy to deal with extraordinary challenges like COVID - this is the area of other policies and should not be intervened as climate polic	
Final observation			
• Well, this of course possible to have a more effective policy during this period, yeah. That is quite obvious .			

Person 8		Who conducted the interview: Krzysztof Krawiec
Whether during policy formulation policymakers have exhausted all potential instruments to meet headline climate goals. If not, was possible to formulate a policy to be more effective?		
Assessment of the instruments	Assessment of policy effectiveness	Others
• The European CO_2 emission trading system was weak at the beginning due to possibilities for loopholes and for taking clean development mechanism credits. • The EU ETS strengthened gradually with a strong decline of the CAP. • The ETS is an example where a much stronger instrument could have delivered the ambition faster and more effectively. • Positive assessment of the instruments to help keep up the price on the market, which makes it now a fairly strong instrument, except for the free-agreements part (considered as still a very weak element). • With a fairly long phase-out period for the free allowances of the carbon border trading scheme, acceptance is disappointing, making it less effective than it could have been. • There is a connection between a political situation and the introduction of the instruments – the Paris Agreement considered a big trigger. • Taxes considered less effective than other instruments as any tax decision is very cumbersome and takes time and is usually rather weak and it requires unanimity • Taxes considered less effective than other instruments as any tax decision is very cumbersome and takes time and is usually rather weak and it requires unanimity • National measures are probably more effective for issues that are not particularly sensitive to international competition.	• The ambition is excellent, but the implementation does not always match it. • Interaction between how technology is moving and what is possible politically speaking (in the context of whether the phase of fossil fuels was possible earlier). • A major bloc like the European Union is able to show declining emissions while the economy is still growing and expanding, a pretty strong signal that it is possible. And it is certainly being noticed by others. • There is European market power, which has an impact through trade relations. If Europe decides that products are not allowed in the EU, that will have an immediate impact on others who produce those products - even stronger than the example of showing that it is possible to have such a policy and not harm the economy. • EU action is always much more effective on issues where there is an international dimension or where there is competition between member states. And even then, national interests come into play when these rules are negotiated. • The problem: not all member states may do their best to reduce emissions from - in that sense the EU is useful to bring others up to speed.	• The EU climate policy has been quite ambitious, particularly after the pair agreement in 2015. • EU had the ambition of delivering its fair share of 1.5° max warming resulting from the Paris agreement. • The action of the EU action aligned with the level of ambition of the global action, which was lower than what we see now. • The EU was the first to embrace the 2 ° target, which was in Paris later strengthened to below 2 or preferably 1.5°; EU in the forefront internationally • Transport and agriculture 'have been the laggards more or less' – the reason for this is that in all individual Member States, transport and agriculture are difficult to tackle due to the very strong lobby with resistant farmers for the agriculture sector. It has always been difficult to push through policy in these sectors; a bit pessimistic about the contribution of the agriculture sectors in the future • Sectors like buildings may have been handled more effectively.
Whether some gaps or barriers have appeared during the implementation of discussed policies. What challenges have been observed during their implementation?		

Person 8			Who conducted the interview: Krzysztof Krawiec
Gaps	Barriers	Challenges	Others
• Weak ETS formulation in the earlier phases (in principle it was a good instrument, but the way it was implemented made it fairly toothless in the beginning) • Lack of actions to avoid deforestation beyond the EU through the import of soy and wood into the EU (was possible to be implemented earlier) • Resisstance from the transport industry (and that's where the US has given in) • The financial sector, which is sort of left out, left aside, while the influence it has on where the money goes in terms of investment is enormous, one of the important articles of the Pairs Agreement is to align all financial flows with the 1.5 to less than two degrees target and we are certainly far from that situation. • Taxes help to adjust the distorted way of prices in the market; if prices would reflect the true cost, there would be no need for taxes, but unfortunately that was not the case.	• Agriculture is certainly something where EU rules are still fairly weak • An issue where pressure from the sector itself leads to another slowing down or dropping certain rules and that's I think the weakness in this system (in the context of agriculture) • Financial sector, especially the directions of investments (see: others) • an important stumbling block – a lot of resistance amongst people to move along and adjust their lifestyles ("no silver bullet to handle that"): There's a couple of things that are important. One is people have to understand much better why these things are unnecessary, and governments are notoriously bad in explaining, that two people they normally argue for a particular instrument or a particular measure. But they forget to tell the behold the whole story about what is at stake and what happens if we don't act. People have to understand why these changes are necessary. Then the second point is that people in at least my perspective, are generally very sensitive about vanish ofactions. I mean there is a general feeling, at least in my country, that the big industries are kept aside, they're	• Instruments that would have a direct impact on where the money is invested, on the share of investments of large financial institutions, and that might be one way of doing it. • politicians in general have always a preference for subsidies, which is not always the best way to get things done (because they don't affect the things that you want to avoid and sometimes, or often maybe even subsidies are ending up where they're not needed because things would have happened anyway. But they only throws money at in places where it's not really necessary • EU policy could have been much stronger in the area of avoiding investments into the wrong sectors (incl. fossil fuels) is a big challenge – taxes is one way to deal with this challenge.	• "What you see now is US trying moving on the on the introducing an ETS for the transport and building sector in order to crank up the price and yeah that is maybe something what could have been done earlier" • Investment was still largely going in the wrong direction and the financial sector is quite insensitive to arguments like risk, risk, because they look at financial things in a fairly short-term way. The long-term risk argument does not have much impact. • The EU could do a lot more in terms of rules for the financial sector, actually not even through the lens of risk, but through direct shares of investment in certain sectors, which I would argue would be much more effective and necessary in order to direct these financial flows in a proper way, which is not the case at the moment at all.

Person 8			Who conducted the interview: Krzysztof Krawiec
	not addressed very strongly with new regulations, but normal people, citizens they are. They've been paying attention on their energy, much higher taxes on their energy than the big industries. And that gives the people the feeling, so why ask me to do things while you haven't asked others and haven't forced others to do their share which is much bigger than mine. So the fairness issue is absolutely critical and the third I think is to see through the psychology of behavior, behavioral change to formulate things and to address things in a way that appeals to people. It must be, politicians have to come up with things that are attractive. They have sort of to paint a future, and that is attractive rather than suffering because you have to change something and that is something that connects to the psychology of people. And I think that's a way to mobilise people and to get them, give them, also maybe another element is to give them a say, to give people a say in how the policies are formulated rather than confront them with a complete proposal that on a take it or leave it basis		
What implication can be drawn from the period 2005-2020 (in terms of ambitions, complementarity, and implementation) for a better formulation of climate policies in the future?			
Ambitions	Complementarity	• Implementation	Others

Person 8			Who conducted the interview: Krzysztof Krawiec
• Not too ambitious - but the issue of citizens awareness of climate actions necessity and science behind the climate policy • "No time to negotiate with the atmosphere" • To challenge climate denialists, political maneuvering necessary, but if you avoid, this becomes a political choice issue, and political choice debate rather emphasises this is about the future of the whole society	n/a	• In terms of financial crisis (and COVID later), there was a flexibility in practice.. although maybe not officially in the way the the instruments and the regulations are formulated – not advocate building that into the written regulations because that would then only lead to using those exceptions and delays, more than all that is being done • "never waste a good crisis" – such a mindset would help and would help to think we covered it was a very good example – there was an enormous drastic in interference with how society runs, leading to enormous changes in people's behavior and activities in various sectors, and there was the hope at that time, that that could be kept, that those changes could be kept for the future. Since many of these things were pointing in the same direction as the climate policy does. But unfortunately, everything evaporated and we're back to normal, right now. So if the policymakers would would think harder, how to use the crisis to really embed or make certain changes structural rather than temporary, that might be useful instruments given that we might face other crises in the future, as you point out. So I would not look at flexibility of regulations at all. I don't think that's useful approach.	• A lot of resistance amongst people to move along and adjust their lifestyles

Considering challenges that have identified in the EU climate policies during 2005-2020, how can the multi-crisis (pandemic, war, energy, and economic crisis) contribute to the transformative change of the EU climate policies in the future?

Challenges	Transformative changes	Others
• Future crisises		

Person 8		Who conducted the interview: Krzysztof Krawiec
• Fragmented innovation policies (little bit here, little bit there – effect is less than what you would like to see, and there's an answer to that and that is what is called mission oriented innovation • EU remains the leader of climate actions, and we are the trouble because the problem can only be solved with the engament of the rest of the world • EU and China policy (even in the foeld of green technology) • Deglobalization due to more tensions between the various blocks in the world – it doesn't help to bring others to the table	• The EU should take use it's market power much more effectively • Role of innovation policy at the EU and member state level - mission oriented innovation strategy, strategy to pull your resources behind a certain purpose • To identify sectors that need the biggest innovation. The steel, the cement, the big chemicals. Then pull your innovation resources behind that and fund those projects, that help you get there. And that's a different way of spending innovation funding • EU help for other countries, especially those poorer in Africa. Help dedicated to deal with the issue, not only the consequences (incl. restructure their economies, help them to phase out fossil fuels as a lot African countries are excited if they find new fossil fuel resources) – a big role to play by the EU	• .We have a market of more than 500 million people. If you set the rules for what can come on that market, you have a big influence on in what's happening in the rest. So now, that is somewhat diminishing given the we are not anymore in the area of globalization, I mean. We are seeing the limits to that right now, but there's still a huge trade volume every day. So, I think there's still a lot you can do with your own market power. And you should be using that much more, I think. And it also helps to eliminate the argument, that there is always a competitor. That is allowed to do differently and if you use your own market for that, you can really be quite effective, I think. I would, you were mentioning the potential future crisis. Yeah, I don't think you can build a policy on that. It's more or less what I said earlier, use a crisis when it occurs and be mentally prepared to do so. But you cannot plan for that. And, so I don't think that's very helpful to formulate future policies in those times. What do you see happening now? Is it sort of a race to be the leaders in the area of green technology? Of course, that is a good thing, when everybody is focusing on that, rather than on defending the outdated technologies. And I think that would certainly help also to redirect the investment flows, and it promotes innovation. And that, I think, is a hopeful trend would that you see emerging. So, I would certainly think that EU should put • Horizon Europe is an umbrella under which a lot of innovation projects are being funded, but that's not what I call mission oriented is. (I want a climate neutral chemical industry by 20 through 45.)

Person 8		Who conducted the interview: Krzysztof Krawiec
		• Impact of climate change became visible not in Europe, but in more vulnerable countries
Final observation		
n/a		

Person 9		Who conducted the interview: Andrzej Kassenberg
Whether during policy formulation policymakers have exhausted all potential instruments to meet headline climate goals. If not, was possible to formulate a policy to be more effective?		
Assessment of the instruments	Assessment of policy effectiveness	Others
• The problem is not the lack of EU legislation when it comes to transforming the goals agreed to by the EU into more sectoral and legislative instruments at the EU level, the problem has always been more about implementation at the member state level. • It cannot be said that the countries of Central and Eastern Europe were mistreated, but the question is whether they were able and indeed effective in allocating these funds, and whether this was on projects of strategic importance (a question of capacity and competence). • The formulation and implementation of instruments required a change in thinking, this is what the climate and energy agenda requires. This was quite fundamental, and the countries of Central and Eastern Europe came to this somewhat later.	• Sectoral policies and standards like: efficiency standards, buildings, cars were not enough motivation to start a real transformation. • Energy packages were adopted, one and two and three, and then some other sectoral legislation but there was no such overarching plan and agenda, which lowered the effectiveness of the policy (like the European Green Deal now). • The essence should be to translate the collective reduction effort into national goals, but the whole thing must come from a comprehensive plan translated later into action. • In many cases, the debate only begins when we actually have a goal that is difficult to achieve, and that affects someone. People are not happy, companies and the government too, but at least there is a conversation about it. Otherwise it can easily be ignored.	• Given, the opportunities and potential for savings, and the potential for energy transformation, etc. this formulated target was of low ambition. • The 2008/9 crisis contributed to some emissions savings that may not have been anticipated earlier. • However, the real debate about climate policy and not about individual sectors (energy) started after the Paris conference i.e. after 2015. • In Brussels and in many Western countries there was not enough understanding of the specifics of Central and Eastern European countries. This may still be the case today, even if the situation is improving, as it eventually became a big political issue.

Whether some gaps or barriers have appeared during the implementation of discussed policies. What challenges have been observed during their implementation?			
Gaps	Barriers	Challenges	Others
• An example of the problems is the implementation of RES	• In reference to the drought, which has become increasingly severe as	• A significant challenge was and is how to convince people and	• The fundamental influence is political representation, which if

Person 9			Who conducted the interview: Andrzej Kassenberg
directives. It has always taken a long time because both the companies and the people in the ministries in charge are very conservative, and they have not been willing to do it on the scale and at the pace that is necessary.	a result of climate change, it came out that we have a system that is highly monetised and incentivises large companies to simply, take advantage of per-hectare subsidies without any environmental criteria or incentives for alternative practices, that is, why should they?	companies as to car-related restrictions/changes because by proposing this you become "public enemy" (lack of public acceptance). And this is both at the level of car production, but also at the level of consumers' rights to actually drive what they want and how much they want. By the way, biofuels are viewed very negatively in the Czech Republic.	driven by business interests builds a negative image as to the EU's climate agenda, and the public largely buys it and does not accept it. It's a question, somewhat sociological, psychological. What causes societies to be so negative at times?
What implication can be drawn from the period 2005-2020 (in terms of ambitions, complementarity, and implementation) for a better formulation of climate policies in the future?			
Ambitions	Complementarity	Implementation	Others
• One of the lessons is that you need a coherent program not only of content, but also of packaging. Just as the European Green Deal has. People and companies despite the fact that it's complicated and technical feel that it's something big and something long-term. The need for a broad view and not just an understanding of the climate, which also applies at the national level. Entrusting this to one DG or ministry is proving insufficient. What is needed is a comprehensive approach and the inclusion of climate in activities that at first glance have no contact with it, e.g. finance, trade or even like taxonomy.	• The idea was to have a fair and open single market, and but still on the principle of technology called neutrality. And it's known that everyone can use whatever they want. I think that's changing a lot now.	• Changes need to be made related to implementation of which the idea of decentralised energy belonging to the community is an example. In fact, on a systemic scale it causes a lot of problems. And it is a costly model, but nevertheless, the point is that it is a model that is fundamentally different from the big corporate energy industry that is going away. • Are member states ready to use finance for the transition? The mental framework is key. Where are our dependencies, how much are we willing to subsidise current prices in order to produce and have value chains in our territories, and are we really ready to reject certain ideas about a liberalised market that have been introduced for many, many decades. And of course, it doesn't seem to be	• The climate and energy debate is very much related to the European debate as such. If you are against EU-backed migration then you are also against EU climate policy. That is why it is so important to use incentives and not just formal regulations.

Person 9			Who conducted the interview: Andrzej Kassenberg
		directly related to the climate, but it is. Let's look at supporting electromobility, subsidies for households to change their heating, and so on. And what about critical materials.	

Considering challenges that have identified in the EU climate policies during 2005-2020, how can the multi-crisis (pandemic, war, energy, and economic crisis) contribute to the transformative change of the EU climate policies in the future?

Challenges	Transformative changes	Others
• Multi-crisis simply means an increased number of variables and increased uncertainty. We don't even know what will happen if we have a full-blown protectionist or trade war. I mean, is it good for the climate or bad for the climate? In the short term, you shorten supply chains. By making people poorer, you can actually reduce your emissions, although, it's very difficult to determine. • Our economy and rich countries create a lot of emissions, even if not necessarily in their own territory, but also just by consuming products and services. So this is definitely something to keep in mind that we don't really see. I feel the decline but liberalised global trade is not very good for the climate and probably not right. • Dealing with acute and urgent things like, making ends meet, paying energy bills, but also some immediate security, because the climate and that's obviously a risk as well, can be something long-term, not very immediate, and therefore something that people just forget about when things get very difficult.	• The point is that for the EU, the Green Deal and the climate agenda should not be seen as an elitist project. And such a high risk exists in Central European countries, and it's just like legitimacy to carry it out in the long term. Crises also create opportunities, as the phase-out of Russian fossil fuels, for example, is a chance for a more favorable agenda.	• There is clearly a fragmentation of the global scene, then in a sense it may even be beneficial in terms of reducing emissions, etc. There will also be a reduction in energy consumption because it is more costly, but it will also create divisions and mistrust among the countries of the international community. But also among people in the communities themselves or in countries. There is a risk of uncertainty about what it will look like after all these crises, and especially after Russia's invasion of Ukraine. Today, signing the Paris Agreement would not be possible. It formally holds climate policy in check. • Important is the response to the IRA introduced in the US but also to what is happening in China, etc. Rather, it's about the international trade situation and the protectionist measures that are being taken by surprising actors such as the US, the biggest proponent of liberalizing markets for many decades. Certainly, the Commission is trying to present from here on the critical raw materials bill, a net zero industry. This means public support and a loosening of regulations, which Germany has apparently requested alongside France. But for medium-sized and not the richest countries, this is not beneficial. If we go

Person 9		Who conducted the interview: Andrzej Kassenberg
		down the road of loosening state aid and systemic support for industrial giants, it is likely that large Western European member states will benefit more.
Final observation		
• The formulation and implementation of instruments required a change in thinking, this is what the climate and energy agenda requires. The real debate about climate policy and not about individual sectors (energy) began after the Paris conference, i.e. after 2015. The politicization of climate policy in member countries has significantly limited it and slowed down implementation. Climate policy is not sectoral but permeates the whole economy and society therefore it must be sold as a common target vision as it is with the European Green Deal. Building and implementing climate policy as the policy of the EU elite will cause opposition from the less wealthy country and the developing world therefore flexibility of approach and understanding of differentiation is critical. Multi-crisis simply means increased variables and increased uncertainty.		

Person 10		Who conducted the interview: Andrzej Kassenberg
Whether during policy formulation policymakers have exhausted all potential instruments to meet headline climate goals. If not, was possible to formulate a policy to be more effective?		
Assessment of the instruments • Much more has happened than could have been expected in the past. • There was a lack of instruments related to urban planning. • It was important to set not too long close deadlines to achieve the goals (12 years is not much). • The dominance of energy-related instruments due to their easier implementation.	Assessment of policy effectiveness • Significant effectiveness of the EU ETS. • Low effectiveness of instruments to improve energy efficiency. • Weak or no instruments to reduce GHG emissions in agriculture and also in transport (strong political blockade).	Others • Climate policy depends on a political mandate so it was difficult to expect more. • For half of the member states, the EU's ambitions are much greater than they would be at the national level. • The EU is not in favor of radical measures being taken, but at the same time, once those wheels are set in motion, they are hard to stop.
Whether some gaps or barriers have appeared during the implementation of discussed policies. What challenges have been observed during their implementation?		
Gaps • Treating the countries of Central and Eastern Europe uniformly and they	Barriers • EU political system requiring long processes to reach a solution.	Challenges • Each member state should develop its own system for financing energy efficiency in buildings.	Others • The weakest link in the implementation of climate policy is the member states and their strong

Person 10			Who conducted the interview: Andrzej Kassenberg
are diverse countries and should be treated as such.			differentiation, their willingness to politicise the spending of EU funds.

What implication can be drawn from the period 2005-2020 (in terms of ambitions, complementarity, and implementation) for a better formulation of climate policies in the future?

Ambitions	Complementarity	Implementation	Others
• The EU has a long-term vision and ambition, and that is good. • Current targets are sufficient excessive raising of ambitions is risky and not very feasible. • When formulating targets, countries outside the EU must be taken into account and interacted with (consumption and historical emissions)	• In a sense, ignore transportation and agriculture in climate policy due to the difficulty of integration. • Introduce a climate test for any action taken in the EU.	• Maintaining national targets sends a clear message of what each country knows what to do and makes it easier to hold it accountable – GHG emissions, RES, efficiency – an important part of communication. • CBAM should cover a wide range of products.	• Make greater use of funds to implement positive solutions. Will introduce the country a given solution will get the fund. • Strengthen civil society go it decides a country's policy - bureaucrats and decision makers come second, and political will, mandate comes first. • Climate policy should take into account the impact on poor people within and outside the EU countries. Services like energy, transportation water and others in limited size should be reasonably cheap but beyond the sufficiency threshold they should be very expensive.

Considering challenges that have identified in the EU climate policies during 2005-2020, how can the multi-crisis (pandemic, war, energy, and economic crisis) contribute to the transformative change of the EU climate policies in the future?

Challenges	Transformative changes	Others
• It has turned out that economies and societies are capable of accepting radical changes (pandemic, war). • The challenge is becoming to significantly increase the share of RES.	• If we have revolutionary situations where people understand that yes, things can change it opens our horizons, in that sense this war was in a way a positive experience, because people understood that yes, you can get rid of the Russians from your economy. • The key to change is building a Net Zero Industry – competitiveness with the US.	• So the last year has shown that it can be done, that we have a lot of power in Europe to make changes if we want to. • Fundamentally reduce the corruption associated with EU funds for the implementation of climate policy to use them more equitably.

Final observation

Person 10	Who conducted the interview: Andrzej Kassenberg
• Despite the difficulties in climate policy, a lot has been achieved in the period under review. It is important to have long-term goals and to break them down into shorter periods. Use a financial instrument like 'forcing' systemic changes in member countries. Integration of climate policy with others is very important (climate test). Recognise important differences in member countries and get instruments for this. There is a lot of power in the EU for systemic change as the pandemic and the war showed.	

Person 11		Who conducted the interview: Andrzej Kassenberg
Whether during policy formulation policymakers have exhausted all potential instruments to meet headline climate goals. If not, was possible to formulate a policy to be more effective?		
Assessment of the instruments	Assessment of policy effectiveness	Others
• A progressive policy framework for introducing climate policy instruments. • Positive introducing a wide range of instruments such as the EU ETS to reduce GHG emissions, mandatory for member countries to share of renewable energy in the energy mix, or improving energy efficiency. • Binding instruments on countries level are important but negotiation process for introduction may contribute to lower ambition, individualism of member countries.	• The implementation of the EU ETS was inflexible and not sufficiently resilient to changing situations such as the economic crisis of 2009-2010.	• The ambitions could have been higher, which has been documented not only by achieving them, but also by exceeding them, in terms of reducing GHG emissions as well as the share of RES, although some countries in the latter did not achieve what was their commitment although there were also countries that went much further in these goals such as Germany, Denmark. • Improving energy efficiency was a non-binding target for individual countries, and the EU-wide target was not met. • Often, arrangements at the EU level influence the strengthening of actions at the member state level. • Often the arrangements made at the EU level during their transposition at the level of member states in a situation of difficulty or resistance have been quoted with the phrase that this is what Brussels wants from us, despite the fact that the representatives of these countries have agreed to such solutions.
Whether some gaps or barriers have appeared during the implementation of discussed policies. What challenges have been observed during their implementation?		

Person 11			Who conducted the interview: Andrzej Kassenberg
Gaps	Barriers	Challenges	Others
• Failure to link price increases in the agricultural sector to efforts to shift to the most healthy and environmentally and climate-friendly diet. • Lack of decisive action in transportation, and emissions have been rising. This applies not only to road but they grew even faster in aviation. The weakness of transport policy on the climate issue is also that since 2011, for almost 10 years, there has not been a new transport policy document at the EU level that could treat these issues more broadly.	• Investment barrier related to the lack of chargeability of pro-climate solutions relative to other subsidised ones. • Significant power of the agricultural lobby in EU decision-making, and so 1/3 of all EU budget allocations go to direct support of the agricultural sector and far too little support for climate policy. • Concerns among politicians about causing food prices to rise if agricultural policy is more strongly integrated into climate issues, which could translate into reduced voter support. This poses a very sensitive issue. • The second issue is road transport where the strong lobby of the automobile industry largely torpedoed stronger climate policy (vehicle emission factors). • The first around aviation and shipping where, in view of the international debate, taking more decisive steps by the EU on its own has been difficult. Despite this, aviation and shipping were included in the ETS, but not to the extent intended. It was definitely difficult in the period up to 2010, but more could be achieved later.	• Make climate policy consistent with other policies like financial policy, tax breaks to support fossil fuels, and agricultural policy.	• Great reluctance to change the Common Agricultural Policy both at the level of member states and in Brussels. This can be seen in almost all EU governments, it can be seen in the European Parliament, where the agricultural lobby is very strong. • Germany's strong position in the automobile industry where, without the country's consent, making changes was difficult. They are supported by the car industries of other countries like France, Italy and the UK. • Despite the fact that the EU is a very good solution, the 27 countries act in many ways, in their own personal interests, so the positions defended by governments when they meet in the EU are inspired by the interests of their own industry or agriculture, sometimes also their own citizens, but mainly by their own industry and farmers.

What implication can be drawn from the period 2005-2020 (in terms of ambitions, complementarity, and implementation) for a better formulation of climate policies in the future?

Ambitions	Complementarity	Implementation	Others

More was possible but the conservatism of the European Commission as well as the EU as a whole resulted in a significant surplus of emission allowances in the EU ETS. Consequently, it led to a lowering of the level of ambition. The goal was to reduce GHGs by 20% and we achieved 32%.	The weak point of the EU ETS is the use of auction revenues because there is resistance from member states to restrictions on their use, and we need funding for long-term radical measures. They are often lost in the budget and serving to increase state revenues becoming political money rather than serving the climate. A better information policy is needed to show the public that auction revenues serve the people so that the transition does not hurt but actually benefits them. Too little funding is being allocated not only to the emergence of innovations but also to bringing them to market.	There is a need for more flexibility and faster response in climate policy in implementing solutions because not everything that may happen in the future can be predicted like COVID.	European climate policy makes sense and should be pursued. For a global problem, the European approach has an advantage over national ones. There is a responsibility towards developing countries for climate change and the EU as a whole should contribute to international climate finance. Today some EU countries do others do not. We are in a period of energy transition, which requires adapting decision-making to changing circumstances and opportunities. For example, in a very shorter time than is currently anticipated, renewable energy sources will become so economically advantageous that they will take over the role of fossil fuels.

Considering challenges that have identified in the EU climate policies during 2005-2020, how can the multi-crisis (pandemic, war, energy, and economic crisis) contribute to the transformative change of the EU climate policies in the future?

Challenges	Transformative changes	Others
• The key is to run to the front i.e. a rapid transition to renewable energy and a reduction in energy consumption, which will contribute to a shift away from fossil fuel imports from politically unstable countries. Alongside this, there will be a significant increase in electricity consumption in transportation and for industrial processes. • The changes are to benefit people, be economically viable technological change alone is not enough. A framework and support from governments is necessary.	• Climate protection is such a complex issue that requires an overarching kind of transformation of many changes in change, and it is very difficult for people to understand. And at the same time it is difficult to manage it. As a result of this complexity, some processes will happen faster than others. • Joint action, long-term with a stable decision-making process so as to reap the benefits. An example is energy efficiency where you need to make a lot of investments in a short period of time so as to reap the benefits later. • You can't run away from difficult decisions, because the closer we get to 2030, the more difficult it will be. Such a difficult decision concerns the food system. It becomes necessary to switch to a more balanced diet, i.e. with less	• Pursue the stabilization of political systems in the EU, which will enable a stable and long-term climate policy. Without this, politicians will not be willing to make bold decisions. Need to strengthen the position of the EU as a whole so that long-term decisions can be made at its level. • Fundamental weakening of the role and importance of the fossil fuel lobby, which is slowing down the transition process. • Technological changes are occurring very quickly and many solutions are already mature but societies are not ready for them are born.

	meat. How much of these decisions are to be made at the national level and how much at the EU level. A very politically sensitive topic concerning both food producers (especially industrial) and consumers, as well as the chemical or pharmaceutical industry.	

Final observation

- Positive recognition of climate policy and its instruments. Too rigid requires a shift toward being more flexible able to respond more quickly to changing conditions. Ambitions could be raised after 2010. Strong role slowing down climate policy from lobbies - agriculture, car manufacturing. Can't put off strong change because 2030 is near.

Person 12	Who conducted the interview: Andrzej Kassenberg

Whether during policy formulation policymakers have exhausted all potential instruments to meet headline climate goals. If not, was possible to formulate a policy to be more effective?

Assessment of the instruments	Assessment of policy effectiveness	Others
• Too weak instruments to implement energy efficiency improvements (e.g., more from auction funds).	• The efforts were not distributed in a partnership manner and the main part of this 3x20 policy effort was imposed on the new EU countries. • Excessive focus on energy (new countries) and not also on transport or agriculture (old countries) resulted in lower policy effectiveness.	• The climate policy of the 2005 - 2015 period was all about learning by doing. • For some politicians and economic activists, it seemed that the goals were impossibly ambitious and impossible to achieve, and over time it turned out that they were exceeded. • More could have been done, but from the point of view of the process of not only goal-setting, but mental, industrial and social transformation, it was not a bad policy (a social and international safety valve).

Whether some gaps or barriers have appeared during the implementation of discussed policies. What challenges have been observed during their implementation?

Gaps	Barriers	Challenges	Others
• Too little allocated auction funds for mitigation activities and related social problems (50% too little, why not 100%).	• Energy efficiency is an area that is very difficult from a regulatory standpoint and is of little use to ruling politicians and individuals.	• For raising the targets and speed of RES development at the European level, there is a	• We have been too conservative about technological advances in RES.

Person 12			Who conducted the interview: Andrzej Kassenberg
		• lack of a more rigorous country-by-country approach. • More emphasis on transport what is already happening and agriculture what is just starting to happen.	

What implication can be drawn from the period 2005-2020 (in terms of ambitions, complementarity, and implementation) for a better formulation of climate policies in the future?

Ambitions	Complementarity	Implementation	Others
• The pace of change as to the reduction of GHG emissions must take into account those less dynamic and those who only during the process realise that the change is taking place, so that they are not left behind, because if we do not take into account this social, industrial, economic aspect, the transformation will simply fail.	• There needs to be a serious conversation about the fact that we should all be making these efforts, and that when it comes to sectors of the economy, energy needs to be zero-carbon, transportation basically also needs to be zero-carbon, and the Common Agricultural Policy doesn't really see climate goals at all.	• We are in such a process that we teach each other and at the regulatory level, and at the technological level, and at the social level i.e. the dimension of the so-called fair transformation.	• Today we have to think about what to do with the next targets after 2030, i.e. 2035, 2040. These targets for 2040 or 2035 will need to be supplemented with new instruments.

Considering challenges that have identified in the EU climate policies during 2005-2020, how can the multi-crisis (pandemic, war, energy, and economic crisis) contribute to the transformative change of the EU climate policies in the future?

Challenges	Transformative changes	Others
• The Green Deal is perhaps the largest regulatory package the Union has ever adopted in terms of scope and speed. And he is that important step towards the 2030 and 2050 goals.	• In Europe, we have a system very much geared towards specific rules, regulations that de facto force, whether industry or consumers, to some specific behavior, sometimes inconvenient. Here a reduction in emissions, here an increase in price, here some ban, here some other requirement. There are 27 countries in	• Today we should be thinking about Next Generation Fund 2.0, dedicated this time 100%, not some percentage, just 100% to precisely climate transformation, to support industries related to transformation, whether in transportation, or energy, or agriculture, or

Person 12		Who conducted the interview: Andrzej Kassenberg
• A European response to the U.S. "Inflation reduction act" is necessary today, it is necessary because we have very different ways of implementing climate policy on the two sides of the Atlantic. • If the EU does not respond to this situation by raising the competitiveness of investment and production and the functioning of the economy in Europe, a large part of those industries that would realise our goals will move to that other side of the Atlantic along with jobs. And then social and political acceptance and the possibility of realizing more ambition goals will be in great question. • The energy industry may be zero-carbon in the near future, but it's hard to imagine a situation in which we have a completely zero-carbon part of industries, and we have to come up with instruments, whether financial, regulatory or some other, that will result in offsetting these emissions.	the EU, and this is politically challenging the need for unanimity. But on the other side of the Atlantic they don't play around, they just for the same thing we do with regulations, they pour mountains of money and say: if you want to produce electric cars, I give you for building a factory one subsidy and for producing every single car a second subsidy, and to the consumer for buying a car, a third subsidy.	waste, or construction - in every simply possible area of green transformation. • The pandemic has certainly brought about a huge cultural shift in terms of how we communicate and meet and the fact that much of our or their interaction is now done through instant messaging. • The energy crisis we're having is the catalyst for a huge acceleration in green transformation.
Final observation		
• Climate policy in the 2005-2020 period was implemented learning by doing and it was generally difficult to do otherwise. Despite this, opportunities regarding: better use of funds from auctions, support for energy efficiency and faster implementation of RES, and broader inclusion of transportation and agriculture in climate policy were not seized. The EU faces challenges such as setting targets for 2035 and 2040 as soon as possible, with appropriate instruments, and responding to U.S. policy so as not to lose industrial competitiveness and accelerate the green transition.		

<table>
<tr><td colspan="3">Person 13</td><td>Who conducted the interview:
Andrzej Kassenberg</td></tr>
<tr><td colspan="4">Whether during policy formulation policymakers have exhausted all potential instruments to meet headline climate goals. If not, was possible to formulate a policy to be more effective?</td></tr>
<tr><td>Assessment of the instruments

• There was no agreement on a carbon tax that's why the EU ETS was introduced even though economists were in favor of tax – not an emissions cap, RES share or efficiency improvements
• It takes many instruments, one for agriculture, another for forests and cars, a third for the energy sector, another ETS, another for building efficiency or renewables.
• National targets in RES have done their job.</td><td colspan="2">Assessment of policy effectiveness

• It is important to be aware of unpredictable events like the collapse of Lehman Brothers or a recession and be flexible.
• The Market Stability Reserve was such an attempt at flexibility - but was it too late.</td><td>Others

• EU climate policy started after the Rio conference i.e. 1992.
• EU is 27 countries without qualified majority decision making would never have been decided.</td></tr>
<tr><td colspan="4">Whether some gaps or barriers have appeared during the implementation of discussed policies. What challenges have been observed during their implementation?</td></tr>
<tr><td>Gaps

• Not fully equitable distribution of reduction or other commitments - the legislation was at the EU level and had an effect on member countries.</td><td>Barriers

• Ensure competitiveness of jobs in industries especially, iron and steel, cement, chemicals and non-ferrous especially aluminum, as well as glass, pulp and paper. They should have been given according to benchmarks allocations for free.
• Need to solve the issue of coal regions almost throughout the EU, which was discussed with DG Regio too late.</td><td>Challenges

• Three key challenges: competitiveness, social problems and coal regions.</td><td>Others

• The timely recognition of the role and importance for climate policy of other policies such as transportation and agriculture has not been made.</td></tr>
<tr><td colspan="4">What implication can be drawn from the period 2005-2020 (in terms of ambitions, complementarity, and implementation) for a better formulation of climate policies in the future?</td></tr>
<tr><td>Ambitions

• Formulating ambitions step by step rather than proposing abrupt changes.
• We should have started 10 years ago to change carbon subsidies in agricultural policy step by step. Not to take resources away from</td><td>Complementarity

• Need to take care of complementarity with other policies, especially in agriculture and transport and as for buildings – in terms of energy efficiency.</td><td>Implementation

• No use of subsidies, grants (the bigger the farm, the bigger they) to reduce carbon emissions and improve energy efficiency in agriculture.</td><td>Others

• Farmers are very conservative happy to use subsidies, but unwilling to change.
The gap between what should be done and what is being done is huge.</td></tr>
</table>

Person 13			Who conducted the interview: Andrzej Kassenberg
farmers, but to redesign the system to be complementary with policy instruments, subsidies, regional policy, etc..			

Considering challenges that have identified in the EU climate policies during 2005-2020, how can the multi-crisis (pandemic, war, energy, and economic crisis) contribute to the transformative change of the EU climate policies in the future?

Challenges	Transformative changes	Others
• The war was an unprecedented challenge for coal as well as the gas market.	• The economy in the aftermath of the war required unprecedented change. • We have more solar panels and energy efficiency. It helps but we are digging up more coal, putting up more LNG, - the war in Ukraine is dramatically changing the energy economics in Europe. • It is important to set long-range goals like climate neutrality 2050 or phasing out combustion engines by 2035 – the business and societies have a chance to get there. It is essential to link this to pragmatism of implementation.	• Too few economists and policymakers are thinking about the implications of the war in Ukraine for climate policy. • It is important to note that the Green Deal agenda is not only about climate and energy, but also about biodiversity. It also applies to agriculture, fisheries and forestry, the banking sector and manufacturing.

Final observation

- Climate policy in the period 2005 - 2020 was generally successful. Climate policy should be built step by step without excessive ambition .It is important to set long-range goals and to link with pragmatism of implementation. Three key challenges: competitiveness, social problems and coal regions. It is essential to integrate climate policy with others such as agriculture, transportation and trade.

Appendix D Involvement of stakeholders in the national cases - interviewees and consultants.

		Investment	Infrastructure	Innovation	Integration
Case 1 (DE)	National		Federal Office of Information Security - Bundesamt für Sicherheit in der Informationstechnik	Producer of an SMGW; Competitive metering point operator	SMGW-administrator In Section 2 Number 20 MsBG: SMGW defined as any natural or legal person who is responsible for the technical operation of the intelligent metering system as metering point operator or on his behalf
	EU		Research community/ grid operators in Italy, Finland and Spain		
Case 2 (NL)	National		The central government (mainly the Ministry of Infrastructure and Water Management and the Ministry of Economic Affairs and Climate policy). Local government (both municipalities and provinces). Other key players are grid operations; the drivers of electric vehicles; installers of charging stations; charging point operators; services providers (enable payment); etc.	The central government (mainly the Ministry of Infrastructure and Water Management and the Ministry of Economic Affairs and Climate policy). Local government (both municipalities and provinces). Other key players are grid operations; the drivers of electric vehicles; installers of charging stations; charging point operators; services providers (enable payment); etc.	

		Investment	Infrastructure	Innovation	Integration
	EU				
Case 3 (BE)	National	Belgian Federal Government Electric utilities Energy project developers Grid operators Customers	Belgian Federal Government Electric utilities Grid operators	Belgian Federal Government Flemish government Grid operators	Belgian Federal Government Flemish government Grid operators Customers
	EU	EU institutions/law (e.g., Belgian renewable energy target under RED) Customers	EU institutions/law (e.g., Belgian renewable energy target under RED)	EU institutions/law (e.g., Belgian renewable energy target under RED)	Customers
Case 4 (PL)	National	Ministry of Environment Ministry of Economy National Centre for Emissions Management (KOBiZE) Research organisations NGOs	Ministry of Environment Ministry of Economy National Centre for Emissions Management (KOBiZE)		
	EU				
Case 5 (FR)	National	French supervisor ACPR French banking institutions			French supervisor ACPR French banking institutions Climate data service providers
	EU	European Central Bank European Banking Authority European Commission			European Central Bank European Banking Authority European Commission
	beyond EU				The NGFS (Network for Greening the Financial System)
Case 6 (FI)	National	Energy Authority Motiva Oy Ministry of Economic Affairs and Employment Municipalities	Energy Authority Motiva Oy		Energy Authority Motiva Oy Ministry of Economic Affairs and Employment Municipalities

		Investment	Infrastructure	Innovation	Integration
		Private sector			Private sector
	EU				
Case 7 (ES)	National	Various Ministries and regional government departments involved in the design and implementation of environmental taxes. Civil society through lobby and interest groups both in favour and against this type of policy. (Ex: Environmental NGO's) Academia: Role in the proposal of several reforms to current instruments		Various Ministries and regional government departments involved in the design and implementation of environmental taxes. Civil society through lobby and interest groups both in favour and against this type of policy. (Ex: Environmental NGO's) Academia: Role in the proposal of several reforms to current instruments	Various Ministries and regional government departments involved in the design and implementation of environmental taxes. Civil society through lobby and interest groups both in favour and against this type of policy. (Ex: Environmental NGO's) Academia: Role in the proposal of several reforms to current instruments
	EU	EU institutions involved in the design of the overarching policy and regulation Civil society through lobby and interest groups both in favour and against this type of policy (Ex: Environmental NGO's)		EU institutions involved in the design of the overarching policy and regulation Civil society through lobby and interest groups both in favour and against this type of policy (Ex: Environmental NGO's)	EU institutions involved in the design of the overarching policy and regulation Civil society through lobby and interest groups both in favour and against this type of policy (Ex: Environmental NGO's)
	Beyond EU				

About the project

4i-TRACTION – innovation, investment, infrastructure and sector integration: TRAnsformative policies for a ClimaTe-neutral European UnION

To achieve climate neutrality by 2050, EU policy will have to be reoriented – from incremental towards structural change. As expressed in the European Green Deal, the challenge is to initiate the necessary transformation to climate neutrality in the coming years, while enhancing competitiveness, productivity, and employment.

To mobilise the creative, financial and political resources, the EU also needs a governance framework that facilitates cross-sectoral policy integration and that allows citizens, public and private stakeholders to participate in the process and to own the results. The 4i-TRACTION project analyses how this can be done.

Project partners

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