Report on national case studies

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Disclaimer

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ACPR	Independent administrative authority which exercises prudential supervision of regulated French financial firms such as banks and insurance companies in France (Autorité de Contrôle Prudentiel et de Résolution)
AFID	Alternative Fuel Infrastructure Directive
BE	Belgium
CBA	Cost-Benefit Analysis
DE	Germany
EEA	Energy Efficiency Agreements
EED	Energy Efficiency Directive
EIB	European Investment Bank
ES	Spain
ETD	Energy Taxation Directive
ETS	Emissions Trading System
EU	European Union
EV	Electric Vehicle
FI	Finland
FOIS	Federal Office for Information Security
FR	France
GHG	Greenhouse Gases
KOBiZE	National Centre for Emissions Management in Poland (Krajowy Ośrodek Bilansowania i Zarządzania Emisjami)
MS	Member States
MsbG	Messstellenbetriebsgesetz
MPOA	Metering Point Operation Act
NCS	National Case Studies
NL	The Netherlands
PL	Poland
PPA	Power Purchase Agreement
RD&D	Research, Development & Demonstration
RED	Renewable Energy Directive
TCCMP	Transformative climate change mitigation policy
TIS	Technological Innovation Systems

Executive summary

This report is the final report on seven national case studies (NCS) performed in the 4i-TRACTION project. It presents outcomes of the analysis carried out in task 2.3 'Evaluation of 4i dimensions at the national level – case-study analysis'. This task focused on the operationalisation of EU climate policies and their interactions with initiatives implemented at the national level. It provides an analysis of Member States' approaches towards achieving common climate policy goals and enables an assessment of national action affecting the 4i's (innovation, investment, infrastructure, and integration). The outcomes of the NCS should be considered three-fold as:

- Operationalisation and examples of methodology to be reproduced in other national cases in 4i's framework
- General recommendations regarding policy assessment performed in diverse MS in various manners
- Source of generalised and specific findings for each "I": innovation, investment, infrastructure, and integration.

The seven NCS covering Belgium (case1), Finland (case 2), France (case3), Germany (case 4), the Netherlands (case 5), Poland (case 6) and Spain (case 7) follow a common structure to facilitate a comparative assessment of national approaches towards the 4i challenges.

Each case study relates to at least two of the 4i challenges. The case studies were selected to illustrate both best practices and challenges associated with addressing the 4i challenges through national climate policy tools and their interactions with the European policy framework. The final framework of the case studies was also guided by a series of workshops covering each of the 4i's.

This report shows the importance of the NCS and the connections among the cases regarding each of the "I's". The section on case study design presents the research questions in all seven cases, the key aspects regarding the 4i's, as well as the subject selection and their relevance for the 4i themes. The role of the 4i themes and EU politics based on the initial results of tasks T2.1 and T2.2 are also included. The subsections on analysis procedure(s), as well as on the results, conclusions and future are also included in form of briefs based on the results of the case studies and general summary of the outcomes.

Additionally, the final report in 4i-TRACTION project will synthesise technical findings on each of the 4i dimensions from Tasks 2.1-2.3 (Task 2.4).

1. Introduction

1.1 Relevance of the NCS

Because transformative climate policies are cross-sectoral and multi-dimensional, thereby affecting more than one area of human life and economy, it is not always possible to conduct quantitative research or define which variables are important and should be measured. Therefore, the abstract 4i concept targeted in the framework needs an additional step of the practical operationalisation of EU climate policy and its interactions with initiatives implemented at the national level in the national cases investigated and described in this report. NCS not only develop the practical operationalisation of the 4i framework but also provide examples for each of the "I"s and their assessments. Operationalisation in the 4i-TRACTION project, means turning abstract concepts (deliverable D1.1) into measurable observations regarding climate policy implementation at the national level. In each case, the respective project partner defined how the concept within the leading "I" can be measured. This is advantageous as the transformative aspect of the studied policy could not have been observed directly. Consequently, the case study analysis serves as a proper mean for systematic evaluation and operationalisation of the 4i concept.

This report focuses on transformative EU climate policies and their interactions with initiatives implemented at the national level, in the Member States (MS) creating the 4i-TRACTION project: Germany, the Netherlands, Belgium, Poland, France, Finland, and Spain. The NCS provide an analysis of MS' approaches toward achieving common climate policy goals. The case studies were selected to illustrate both best practices and challenges associated with addressing the 4i dimensions through national climate policy tools and their interactions with the European policy framework.

1.2 Connections among the cases

The cases were chosen to be linked among each other and to be representative of the "I". Special attention was paid to that matter during four workshops on NCS:

- 4i-TRACTION Expert Workshop on Transformative Innovation for a Climate-neutral European Union (EU) - Innovation workshop: 28 April 2022, 10.00-12.00;
- 4i-TRACTION Expert Workshop on Transformative Infrastructure for a Climate-neutral European Union - Infrastructure workshop: 10 May 2022, 10.00-11.30;
- 4i-TRACTION Expert Workshop on Transformative Investment for a Climate-neutral European Union - Investment workshop: 17 May 2022, 14.00-15.30;
- 4i-TRACTION Expert Workshop on Transformative Integration for a Climate-neutral European Union - Integration workshop: 18 May 2022, 9.00-10.30-15.30.

All the 4i's are covered in the NCS. Thereby, the focus is put on one "I" in particular in the case. Table 1 presents an overview of the NCS and the "I" that they relate to.

Table 1. Overview of the 4i's covered in the national case studies.

Country - case	Innovation	Investment	Infrastructure	Integration
Belgium (BE) – Case 1	XX	X	X	
Finland (FI) – Case 2		X	X	XX
France (FR) – Case 3		XX		X
Germany (DE) – Case 4	X		XX	X
Netherlands (NL) – Case 5	X		XX	
Poland (PL) – Case 6		XX	X	
Spain (ES) – Case 7	X			XX

Explanation: Leading "I" -XX, additional "I" – X considered in the case

Transformative climate policy should facilitate the systemic change that is needed to drive our economies to become climate neutral. Therefore, a sectoral approach alone would be insufficient. Consequently, in the NCS, the use of the 4i-TRACTION approach has helped to overcome these issues as it is organised around four cross-cutting challenges. These four EU climate policy key vectors that foster a transformation toward 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.

Even though each case covers a different policy in a different country and the scope of the case is specific to the field covered, 4i's thematic bridges between the cases can be found. The 4i's in cases were summarised in detail in sections 1 and 2 of this report. The instances are connected not only when they address the same "I," but also when they address different policies, as in Belgian (Case 1) and Dutch cases (Case 5) for infrastructure, where, on the whole, the recommendations regarding power grid adaption might be combined for some sort of new foundation to create proper regulations for climate transitional infrastructure. Additionally, the recommendations at the European, national, and sometimes regional level from one MS could be

helpful for the other even when planned infrastructures are different. It considers surrounding coordination, cooperation with different levels of government, and cooperation across industries.

Moreover, diverse cases may also touch upon different aspects of the same "I" and 4i challenge, for example in the case of innovation:

- Technological innovation - Belgian (Case 1) and German cases (Case 1),
- Business model innovation – Dutch case (Case 5),
- Policy context in innovation – Spanish case (Case).

Different kinds of connections among cases can be observed after grouping recommendations from the cases addressing similar national institutions and, stakeholders on the same regional/national/European level. It helps to address a group of similar problems and to assess the level of governance at which those issues should be addressed. Further, it helps to create a comprehensive strategy enabling better climate policy creation and implementation.

1.3 Case study design

This section provides an overview of the key aspects of each case analysed.

1.3.1 Belgian Case (Case 1)

Table 2. Case study design 1 - Belgian offshore wind: Innovation and Investments

infrastructure Belgium	**Belgian offshore wind: Innovation and Investments (Case 1)**
Partner	Vrije Universiteit Brussel
Background	The case was developed based on the importance of offshore wind to climate neutrality scenarios for the EU and Belgium's high ranking for current installed capacity. The case looks at how the successful implementation of Belgian support for offshore wind led to these developments as well as weaknesses and lessons learned for other MS/countries.
Research questions	• Did a Belgian offshore wind energy ecosystem emerge following offshore wind energy development in Belgium? • Did the Belgian initiative to develop offshore wind induce technological innovation and business model innovation in Belgium? • What are the main features of offshore wind investment in Belgium and what are elements that contributed to the successful development of offshore wind?

Relation to climate policy at the EU level and in the Member States	This is partly a matter for empirical exploration during the case study, but we expect important interactions between Belgian direct renewables support policies and the EU-level policies in which they are embedded, such as the Renewable Energy Directive and its national targets as well as planning aspects such as the National Renewable Energy Action Plans under the RED and more recently the National Energy and Climate Plans and National Long-Term Strategies under the 2018 Governance Regulation.
Case study's main objective	A long-term, qualitative case study of the development of offshore wind in Belgium, focusing especially on the 4i's.

1.3.2 Finnish Case (Case 2)

Table 3. Case study design 2 - Voluntary Energy Efficiency Agreements

integration **Finland**	**Voluntary Energy Efficiency Agreements (Case 2)**
Partner	University of Eastern Finland
Background	The single most important policy instrument to implement the energy efficiency requirements set in the Energy Efficiency Directive (EED) in Finland is the wide use of voluntary energy efficiency agreements (EEAs). Voluntary EEAs have been used in Finland since the 1990s and have so far delivered the targeted energy savings. EEAs are chosen in cooperation by the Government and industrial or municipal associations in different sectors and are an alternative to new national legislation or other coercive means.
Research questions	• What are the factors that explain the success of the EEAs as a policy instrument to implement EU energy efficiency policy in Finland? • Whether this can be explained by their design features, national circumstances or a combination of these.
Relation to climate policy at the EU level and in the Member States	As the main instrument in implementing EED requirements, the voluntary EEAs approach differs from many others. First, the EEAs have been used in Finland already before the EU set any legally binding energy savings targets. As an established instrument, EEAs have the potential to explain how the private sector could be engaged in the implementation of energy efficiency policies without any mandatory schemes. It provides an example of how there should be flexibility in MS' choices of implementing EU climate and energy policies at the national level. Second, regarding the EEAs, the cooperation between public and private actors is fully based on voluntary commitments. There have been unsuccessful attempts at the EU level to adopt measures based on voluntary aspects, but this case study demonstrates how they can work at the national level.
Case study's main objective	The Finnish case study aims to identify the factors that have made voluntary EEAs successful in meeting energy efficiency requirements. It is assessed how these factors have contributed to the success of the voluntary EEAs. This is done by

	examining the existing policy documents and with expert interviews to gain insights and experience from the field.

1.3.3 French Case (Case 3)

Table 4. Case study design 3 - Climate stress tests: what co-benefits can we expect for transition financing?

 **France**	**Climate stress tests: what co-benefits can we expect for transition financing? (Case 3)**
Partner	I4CE
Background	The case study focuses on the evaluation of climate stress tests, which are new financial regulatory instruments that aim to assess the sensitivity of banks to climate-related risks. These exercises were launched under the drive of the Network of Central Banks and Supervisors for Greening the Financial System, the network of various national central banks for greening the financial system. Climate stress test is one of the key elements that figure in the European Commission's sustainable strategy. The first role of the climate stress test is to evaluate if the financial system is strong enough to face the consequences of climate change and the transition to a low-carbon economy. The indirect role of climate stress test is their influence on banking institutions' investment strategy and mainstreaming of climate issues in their activities.
Research questions	This study seeks to identify the possible co-benefits of climate stress test on transition financing, as well as their limits in this regard. The study makes the hypothesis that a better understanding and practice of climate risk management could modify banks' internal decision-making processes and thus potentially improve their ability to finance the transition.
Relation to climate policy at the EU level and in the Member States	Climate stress tests are instruments used by financial supervisors that can be replicated at the national level, as it was the case for example for the Netherlands and France, as well as at the European level, as it was the case with the European Central Bank. Thus, although the impact study focuses on French financial institutions, its results may be of interest and use to other EU countries, as well as to the European institutions themselves.
Case study's main objective	The case study's main objective is to evaluate the impact of the climate stress test among other instruments on the global decarbonisation strategy of the EU. More specifically the impact study evaluate the role of the climate stress test in shifting investment toward a greener economy and their role in accelerating climate mainstreaming within financial institutions and financial supervisors' activities.

1.3.4 German Case (Case 4)

Table 5. Case study design 4 - Germany's delayed electricity smart meter rollout and its implications on innovation, infrastructure, integration, and social acceptance

innovation **Germany**	**Germany's delayed electricity smart meter rollout and its implications on innovation, infrastructure, integration, and social acceptance (Case 4)**
Partner	Ecologic Institute
Background	Our energy transition from a centralised to a decentralised volatile renewable energy generation requires a smart digital grid infrastructure to measure fluctuations in real-time to ensure grid and supply security. The third internal market directives for electricity and gas requested the creation of a legal basis for the introduction of smart metering systems or at least to carry out an economic assessment of the justifiability (cost-benefit-analysis - CBA) of the 'rollout'. In the case of a positive CBA, the European goal was to reach a rollout of 80% of consumers by 2020. 11 MS have reached this rollout-rate while in Germany only a small fraction of consumers is equipped with a smart metering systems[1]. After a generally positive CBA in 2013, Germany passed in 2016 the "law on metering point operation and data communication in intelligent energy networks (Messstellenbetriebsgesetz – MsbG)". The aim of the MsbG is to create a technical infrastructure for the energy transition by introducing modern measuring devices and intelligent measuring systems.
Research questions	• What main factors delayed the smart meter rollout in Germany? • What are the implications of the delayed rollout on the 4i-dimension[2]: innovation, infrastructure, integration, and social acceptance? a. How has the German approach impacted innovation in terms of technological diffusion, the creation of new business models and policy innovation? b. How has the German approach impacted the establishment of new infrastructures? c. How has the German approach impacted integration into the electricity network?
Relation to climate policy at the EU level and in the Member States	The case identifies how Germany implemented EU policy relating to smart metering systems.
Case study's main objective	Identify relevant barriers in the German approach for a large-scale smart metering rollout by analysing the EU and German legal frameworks. The study also uncovers whether the German approach is of transformative character within the context of innovation, infrastructure, integration and social acceptance.

[1] Tounquet, Alaton 2019, Benchmarking smart metering deployment in the EU-28, 59.
[2] In line with the 4i-TRACTION project, the four core challenges to transformative climate EU policy are innovation, investment & finance, infrastructure and integration.

1.3.5 Dutch Case (Case 5)

Table 6. Case study design 5 - The rollout of public charging infrastructure for electric vehicles in the Netherlands – Innovation and infrastructure

infrastructure **The Netherlands**	**The rollout of public charging infrastructure for electric vehicles in the Netherlands – Innovation and infrastructure (Case 5)**
Partner	Wageningen University
Background	To achieve climate neutrality by 2050, the EU economies will have to shift from fossil fuels to green energy: An industrial revolution against a deadline (Tagliapietra and Veugelers, 2022). To facilitate this transition EU policy will have to be reoriented from realising incremental change to realizing transformative change. One of the sectors that will play a key role in this shift is transportation, in which electric vehicles (EVs) will need to substitute fossil fuel vehicles. EVs require a public EV charging infrastructure. In 2020 the Netherlands is a leader in the EU, and possibly the world, in terms of both the quantity and quality of its public charging infrastructure.
Research questions	Main research question: To what extent did Dutch public policies resolve (potential) impediments to the rollout of public charging infrastructure in the Netherlands between 2009 and 2020. Sub questions: • What are the impediments to the adaptation of innovations (according to the literature)? • How to evaluate transformational climate change mitigation policies? • Which public policies and policy instruments were used to influence the rollout of charging infrastructure during the period 2009-2020? • What can we learn from this to accelerate the rollout of public charging infrastructure in other countries? • What can we learn from this for evaluating climate change mitigation policies?
Relation to climate policy at the EU level and in the Member States	The decarbonisation of road transport in the Netherlands through EVs in the period 2009-2020 is related to the '20/20/20 by 2020' strategy of the EU, which started end of 2007. This strategy aims to reduce greenhouse gases (among which carbon dioxide) by 20% in 2020 compared to 1990 emissions. It is also closely related to having a 20% share of renewable energy in total energy consumption by 2020. Other important EU policies are the European Strategy for Low-Emission Mobility from 2016 and the European Green Deal, through anticipatory behavioural effects. It is also related to the EU 2030 targets set in 2014. The variation in the number of charging stations between MSs is big. To illustrate, around half of EU-27 MSs have less than 2 (public) charging stations per 100 square kilometres whereas in the Netherlands it is much higher (Balko et al., 2021). As such, the policy experiences in the Netherlands could inform policy-making in other EU countries.
Case study's main objective	The main objectives of the case study are: • Develop and apply criteria (i.e., a normative framework) to evaluate individual climate change mitigation policies • Describe and analyse Dutch policies regarding charging infrastructure • Identify lessons

1.3.6 Polish Case 6 (Case 6)

Table 7. Case study design 6 - Evaluation of the impact of the EU ETS revenues and derogation 10c on investment and infrastructure in Poland (Case 6)

 **Poland**	**Evaluation of the impact of the EU ETS revenues and derogation 10c on investment and infrastructure in Poland (Case 6)**
Partner	WiseEuropa
Background of the case understood as policy/mechanism/tool being assessed in the case study	Article 10c of the EU ETS Directive provides a derogation from the general rules on no free allocation for electricity production. It enabled lower-income MS to give free allocation, from the amount already allocated to that MS for auctioning, to installations for electricity generation, to support investments contributing to: • diversification of the energy mix and sources of supply • restructuring, environmental upgrading, and retrofitting of the infrastructure • clean technologies • modernisation of the energy production sector and the transmission and distribution sector. This provision was introduced for phase 3 of the EU ETS (2013-2020) when auctioning became the default method of allocating allowances for electricity generation. In the context of the 2030 climate and energy framework, EU leaders decided that it should also be available during phase 4 of the EU ETS (2021-2030) pointing out the need to improve transparency to ensure that the free allocation is used most effectively. Additionally, there is an option related to the Modernisation Fund that improves the transparency of the allocation process under Article 10c.
Research questions	• How did Poland benefit from the derogation laid down in Article 10c of the Directive 2003/87/WE (who benefited the most, and what investments were related to this process)? • How was the income from the sold emission allowances invested in decarbonisation?
Relation to climate policy at the EU level and in the Member States	European policy was implemented and adopted, and Poland used the opportunity to create Article 10c. The ETS Directive contains the general principle that all allowances that are not allocated free of charge are to be auctioned. The European Commission estimated that about 50% of the total amount of allowances would be auctioned during 2013-2020. The rest of EUA allowances were allocated free of charge between energy-intensive industry sectors (exposed to the risk of carbon leakage), other manufacturing industry sectors (received 80% of its allowances free of charge in 2013, but this decreased annually to 30% in 2020), and the power sector in some MS, including Poland. The total number of allowances to be auctioned in 2013-2020 is available in the table on the EU website.
Case study's main objective	Evaluation of both EU and state policy framework on the example of the EU ETS can help to identify the biggest gaps in phases 2 & 3 of ETS and assess if they were addressed in phase 4 revision as well as potential space for further improvements beyond it.

1.3.7 Spanish Case 7 (Case 7)

Table 8. Case study design 7 - The role of energy and environmental taxes in Spain

integration Spain	**The role of energy and environmental taxes in Spain (Case 7)**
Partner	University of Vigo
Background	Although energy and environmental taxes have for a long time been considered an important part of the policy mix to advance the climate goals, it has not been used in the same way among MS. Spain poses an interesting case where this type of instrument has not been used to its full potential. It is interesting to try to understand why that is to be able to come up with improvement proposals.
Research questions	• How effectively has EU legislation managed to harmonize environmental taxation? How has the legislation impacted MS (and specifically Spanish) taxation policies? • Have environmental taxes in Spain been implemented successfully and contributed to advance towards climate change mitigation? a. What have been the distributional effects of the policies? b. How have the different levels of jurisdiction (local/regional/central) affected the policies and its results? c. What has been the role of harmful subsidies? • What are the implications/lessons from the 4i perspective: Integration and Innovation?
Relation to climate policy at the EU level and in the Member States	The case study is related to the Energy Taxation Directive (2003/96/EC). Considering that the directive includes among its goals to achieve a low carbon economy it is relevant to assess to what extent the implementation at the MS level has managed to advance in that direction. As the debate is ongoing on the reform of the Directive as part of the changes needed to achieve the new climate goals, this topic acquires increased relevance in terms of providing insights through the ex-post assessment, of what worked well and what did not. There is also a Specific link with the Excise Duty Directive which, although with no specific environmental focus, regulates taxes on fuels that do affect the environment. Additionally, in a broader sense, the case is linked to the climate policy goals of the EU. Considering the period of study (2005-2020) these are well summed up with the 20/20/20 targets.
Case study's main objective	Have a better understanding of how environmental taxes related to climate change mitigation have been implemented in Spain. With the assessment of what worked well and what did not, we expect to be able to provide some insight on how to improve the implementation of this type of instrument.

1.4 Case selection and their relevance for the 4i's

1.4.1 Innovation

The aspect of stimulating innovation to transform the material base of the EU economy is a central topic in Belgium (Case 1) and Germany (Case 4), but also relevant for the Netherlands (Case 5) and Spain (Case 7). The additional recommendations on technological innovation and business model innovation, as well as policy and governance innovation for new governance solutions, are based on the outcomes of all mentioned cases.

The Belgian case (1) focuses on the interplay between innovation and investment, specifically how innovation can move producers along technology learning curves and thus reduce costs. The study helps to understand how the investments in offshore pushed innovation across the value chain to the overall advantage of the industry in Europe and worldwide. Belgium has become a global player in the construction of offshore wind parks and infrastructure due to its choice to develop offshore wind as one of the first countries. Two companies, Jan De Nul, and DEME are active in the development of offshore wind in the EU, US, Taiwan, and Japan. Belgium has also become a global leader in modular offshore grid construction, with around 40% of these substations being constructed in Belgium. Maritime engineering companies in Belgium have large market shares due to the early development of offshore wind in Belgium and their investment in innovative offshore wind construction and maintenance ships. They also hold a large share of offshore wind-related patents published by the Belgian patent office between 2002 and 2022, allowing them to engage in larger offshore wind construction outside of Belgium and Europe.

German case (Case 4) considers **technological innovation** – and the interplay between technological innovation, infrastructure, and regulation. The study focuses on the rollout of smart meters establishing a new market for modern technology, products, processes, and services. The technological innovation regarding communication, IT security, and data protection, as well as interoperability was recognised as particularly important to investigate.

The EU must digitalise its energy systems and make it easier for its economies to become electrified in order to reach climate neutrality by 2050. In this direction, smart energy grids combine energy consumption, storage, and production. Within this smart energy grid, smart metering systems can empower consumers and energy suppliers by providing valuable data to monitor energy generation and consumption. Ex-post analysis of the European and German legislative framework from 2009 to 2021 and beyond to determine the reasons for Germany's delayed smart meter rollout. Specifically, the process of the Metering Point Operation Act (MPOA) in Germany was traced, which is the primary policy governing the country's smart meter rollout.

The Dutch case (5) can contribute to describing not only technological but also **business model innovation** by showing an innovative aspect in the introduction of an EV charging network in the period 2009-2020. Like the German example, it thus also relates to the interdependence between innovation and infrastructure. The innovation in the sense of Schumpeter's diffusion

(i.e., spreading out charging points across the Netherlands) and innovation (i.e., improving the business case of charging points; designing a market for public charging points). The Netherlands are a leader in the number of EV charging stations in Europe. As such, it might illustrate how a number of classical innovation dilemmas can be dealt with in a successful way, e.g., surrounding standards, business case innovation, or setting up a market for charging points.

As the 4i-TRACTION project also wants to adopt a system-wide perspective, the **policy context in innovation** is considered in the Spanish case. It helps to understand how actors active in the field shape innovation outcomes, as well as the role of specific Research, Development & Demonstration (RD&D) policies and the broader political framework conditions. The link to innovation in Spanish Case (Case 7) is, on the one hand, the idea that environmental taxes promote the uptake of less carbon-intensive alternatives by increasing the price of polluting products/services. Consequently, the study assesses if that has been the case in Spain and, if not, what could have been done differently to enable this innovation effect. On the other hand, there is a link to policy and governance innovation, in the sense that a better design of instruments could probably lead to improved policy outcomes. The case showed that environmental taxation can have a modest impact on decarbonization, but its full potential is missed due to the shortcomings of existing instruments and the system as a whole.

1.4.2 Infrastructure

Rolling out the infrastructure for a resilient climate-neutral economy is considered in Belgium (Case 1), Germany (Case 4), the Netherland (Case 5) additionally in Finland (Case 2) and Poland (Case 6). In the NCS analysis, was recognised which new infrastructure is needed for climate neutrality, which needs to be upgraded, which can be converted, and which becomes outdated. The cases listed above describe the policy instruments and governance to develop an EU infrastructure compatible with climate neutrality and how they support the co-evolution of infrastructure and technologies, incorporate uncertainties, and handle delays.

The Belgian case (Case 1) focuses on the infrastructural bottlenecks of offshore initiatives in the electricity grid – high voltage connections. The study considers a few obstacles encountered by new infrastructure: technological, economical, legal, and Not In My Back Yard problems and consider those for the deployment of offshore wind.

The offshore wind industry in Belgium has developed over the last two decades, with high-tech activities such as consulting, verification and accreditation, maintenance, surveying, safety and safety training, IT services, and remote sensing. There is strong evidence for innovative entrepreneurial activities related to offshore wind in Belgium, with specialisation in Belgian offshore wind services focusing on innovative software, AI, data monitoring, and remote sensing relevant to the development and operations, and maintenance of offshore wind (infrastructure). Most of the offshore wind capacity is owned by Belgian companies or public sector stakeholders, with a large share of public sector ownership. Belgian municipalities also play an important role.

The German case (Case 4) addresses the interplay of physical infrastructure with regulations and markets, as well as the digitisation of the energy system and (smart) infrastructure. The German approach to setting up an electricity smart grid can serve as a blueprint on how not to digitalise other sectors. The smart meter rollout is a very significant pre-condition for the digitisation of the energy system by establishing a whole new system of multi-polar communication and information systems between numerous entities at distinct levels.

The Dutch case (Case 5), which analyses EV charging stations in Europe outlines necessary alterations to the power grid and the development of information systems to inform users where to find charging stations. This case illustrates how a number of classical infrastructure dilemmas can be dealt with in a successful way, e.g., surrounding coordination, cooperation with diverse levels of government, and cooperation across industries.

The Finnish case study (Case 2) on EEA shows a cost-efficient way to develop the energy infrastructure. The focal point is the security of supply which requires improving energy efficiency measures. This case helps in understanding the role of voluntary EEAs in improving the security of supply and energy self-sufficiency. EED requires MS to achieve yearly energy savings through an energy efficiency obligation scheme, but MS may opt for alternative measures. In Finland, the main policy instrument to implement the obligations set in the EED is voluntary energy efficiency agreements. This case study was conducted to understand the factors that have made the Finnish system of voluntary EEAs successful and effective in delivering energy savings. The EEAs are used across sectors (energy, industry, services, municipalities) and have proved significant in delivering the required energy savings. Voluntary EEAs are a flexible system of EEAs and action plans for each sector. It has proved very cost-effective in delivering targeted energy savings. Many of the features of the EEAs are aligned with the needs of transformative climate policies. One of the key challenges of transformative climate policy is the need to involve actors across all sectors and different phases of the process, and this case study demonstrates how the EEAs include various actors from different levels and sectors. Another key feature of the EEAs is a wide and network and practice of exchanging information between participants, thereby encouraging others to implement further energy efficiency measures.

The Polish case study (Case 6) pictures issues connected to the under-regulation of infrastructure financing. It shows the investments eligible to bid, including upgrading and retrofitting the infrastructure, efficient and sustainable district heating, and the transmission and distribution sector. The case helps to answer questions about why these types of infrastructure were chosen and how they contribute to climate targets.

Activities reported in Poland to the European Commission show that investments in infrastructure did not constitute a significant share of the reported activities. In the listed activities there are relatively small local projects related to smart metering or modernization of the heating network, but they do not hold a significant share of the total number of allowances. According to the Directive, derogation under Article 10c may have been granted for the following five types of eligible investments: retrofitting of infrastructure, upgrading of infrastructure, clean technologies, diversification of energy mix, or diversification of sources of supply. Infrastructure is defined more

broadly than just transmission and distribution grids – it also includes generation units. The poll outcomes indicate that in terms of infrastructure, funds were dedicated to the expansion of transmission infrastructure. The funds also gave minimal support to the energy transition, e.g., through infrastructural upgrades and expansions.

1.4.3 Investment

Shifting investment and finance are the main topics in France (Case 3) and Poland (Case 6), but some conclusions can be also drawn from Belgian (Case 1) and Finnish (Case 2) case studies with wider perspective and analysis of the implications of a granular perspective. Cases have already identified specific instruments with a high transformative potential for mainstreaming climate issues in the financial sector.

The French case study (Case 3) on the impact of climate stress tests focuses on how and to what extent climate stress tests conducted by financial supervisors on banks succeed in accelerating the phase-out of fossil fuel technologies and thus had a transformative effect on green investments. The case addresses the role of financial regulators and supervisors in Europe and proposes steps to better incorporate climate issues. Additionally, it demonstrates how to develop options to improve the internal procedures, incentives, and governance structures of financial institutions for integrating climate issues. It assesses whether the test has enabled them to change their investment criteria.

The Polish case (Case 6) adds to investment "I" by following the climate-friendly investments made within the benchmarks in EU ETS contributing to the phase-out of fossil technologies. The case forms the basis to identify relevant characteristics and tools for a transformative exit from coal-related investments in the real economy in Poland. The case examines the effects of two forms of funds in EU ETS, Derogation Article 10c and auction revenues, on Poland's infrastructure development and investment levels. The investigation helps develop options to improve financial institutions' internal procedures, incentives, and governance structures for integrating EU ETS regulations into their framework facilitating energy transition. The study also reviews and clarifies the mandates of financial regulators and supervisors to better include the recommendations for a transformative ETS system in the iterated version for future climate issues.

Auction earnings must be used for energy transition initiatives, but Poland's actions cast doubt on the Directive's compliance. The derogation mechanism was not future proof since the generating market was consolidated, and reported investments focused on upgrading conventional producing capacity.

The Belgian case (Case 1) follows the investment from private and public actors in the deployment of offshore technology and R&D to lower costs. It helps to assess the importance of policy support and investigates the mainstreaming of wind investment in the national and European financial sector. The study can help to learn lessons from (early) investment in large-scale renewable energy projects and changes over time. The ownership of offshore wind in Belgium is a mix of private and public actors, and the capital made available is also a mix of public and private funds.

The European Investment Bank (EIB) provided a substantial part of the financing for all Belgian offshore wind parks, with 33% of capital provided via the EIB. Two elements helped to bring about long-term investment certainty: green energy certificates (17-20 years) and Power Purchase Agreements (PPA's). PPAs are commonly used in Belgian offshore wind, and energy companies act as intermediaries to conclude downstream PPA's with final consumers. PPA's can provide a form of supply and pricing stability and allow energy intensive companies to green their production.

The Finnish case (Case 2) adds information on promoting investments in different sectors as commitments to energy efficiency measures require investments in clean technology solutions. Voluntary EEAs also incentivise investments on energy efficient technology. EEA participants may be eligible for energy aid for conventional technologies promoting energy efficiency, not only the development of new technology. Energy audits for SMEs and municipalities committed to EEAs are also subsidised. These audits aim at identifying possible energy efficiency measures for companies and push the companies towards engaging in more energy efficient actions.

1.4.4 Integration

The issue of integration across traditional policy areas in the 4i-TRACTION project explores what an 'all-of-government' approach to transformative climate policy would entail at the EU level, and how the coordination of parallel, interdependent processes in different policy areas can be achieved. Cases consider integration across economic sectors and technological trajectories. They investigate how to provide tools to respond to the governance challenges arising from the erosion of classical sector distinctions/coupling and at the same time ensure coordination across parallel, interdependent processes of technological change.

The cases from Finland (Case 1) and Spain (Case 7) address integration as a central topic, supported by cases from the Netherlands (Case 4), Belgium (Case 1), and France (Case 1).

The Finnish case (Case 2) focuses on EEAs that cover various sectors and thus offer cross-cutting solutions. The integration is considered as integrating energy efficiency targets and measures in decision-making also at the local level (climate policy integration). EEAs are policy instruments suitable for various sectors, the aim of the dedicated case is to identify the key factor behind the success. In Finland, voluntary EEAs are a practical means of achieving the energy efficiency standards imposed by EU regulations. The system's adaptability has made it possible for it to be widely used in a variety of industries. Participants have all made commitments to implement energy-saving initiatives throughout their businesses. In addition to the EED, EEAs are utilised to carry out duties established under other policies. Energy-efficient use, encouraged by the EEA, is incorporated into the management systems of a firm and so directs activities to continuously become more energy-efficient. As a result, energy efficiency efforts go beyond the ones that are specifically stated in EEAs, and a commitment to energy efficiency may even spur more climate action.

The Spanish case (Case 7) considers policy integration to see if there is coherence and coordination within the different instruments applied. In the Spanish case, there is also a geographical/jurisdiction aspect since some of the affected policy areas are regulated at the regional level. The lack of coordination among various jurisdiction levels is already identified as one of the challenges of integration policies in Spain. This case study examines the implementation of energy and environmental taxes in Spain and their role in climate change mitigation in the 2005-2020 period. It highlights the lack of harmonization of environmental taxation, which leads to uneven implementation at the MS level. The difficulties and complexity of using these tools may be seen in Spain, which offers an intriguing case study. One of the most distinctive aspects of the Spanish situation is the complexity of jurisdiction brought about by the division of taxation authority between the national, regional, and municipal governments. This has resulted in the development of several instruments, many of which lack a comprehensive strategy and have modest environmental goals.

The German case (Case 4) helps to gather knowledge about the integration in the meaning of 'integration across relevant sectors of the energy market'. The rollout of smart meters has the potential to accelerate the implementation of combined heat and power systems, photovoltaic systems, or other controllable energy-consuming or energy-providing appliances (e.g., systems of electro-mobility) and thereby contributes to the integration of the sectors of electricity, heating (or cooling), transport and industry – in other words, sector coupling. This is especially important with increasing renewable energy use and in view of reaching climate-neutrality by 2050.

The Belgian case (Case 1) included economic and policy integration with other sectors (electrification of transport, possible role in hydrogen economy). The study discusses issues related to the integration of offshore wind in the EU power system and synergies with other sectors (e.g., industry).

The French case (Case 3) evaluates the role of climate stress test exercises in climate mainstreaming within banking institutions and financial supervisors, and how they helped in raising awareness about the importance of climate and transition issues within banks' teams, including the top management of the banks. It also assesses the role of climate stress tests to help banking institutions to better understand the link between the different sectors regarding transition issues, and how it allowed them to adapt their sectoral policies regarding these issues.

2. Role of the 4i's and EU politics

Key goals of the climate policy – 2020 in the innovations aspect can be described as a challenge in several types of innovation and their possible contribution to achieving EU climate neutrality by 2050, the policies in this area were created to support reaching three main targets:

1. Greenhouse gas emission (GHG) reduction of 20% -20% reduction in GHG emissions by 2020 compared to 1990

2. Renewables 20% - 20% of energy from renewable sources overall, 10% of energy from renewable sources for transport
3. 20% improvement in energy efficiency[3]

Ambitions listed above can be also found in national cases and connected to the headline targets considered in T2.1 and T2.2.

The Belgian case (Case 1) shows how the investments in offshore pushed innovation across the value chain to the overall advantage of the industry in Europe and globally. Moreover, it investigates if Belgian companies profit from being early movers in the field.

The Belgian, Dutch, Polish, and Finnish cases give complementary knowledge to the analyses performed in WP2 about MS's policy regarding Renewable Energy Directive (RED), Alternative Fuel Infrastructure Directive (AFID), ETS, and Energy Efficiency Directive (EED), respectively. Those support qualitative and quantitative evaluation of climate policy in the EU.

The German case (Case 4) provides useful lessons about the challenges of up-scaling innovations while their development is still ongoing and the trade-offs that policymakers have to navigate. This is especially true for the trade-off between concerns about data protection and cyber security on the one hand and the demand for a quick and low-cost rollout of this enabling technology on the other hand.

To achieve climate neutrality by 2050, the EU economies will have to shift from fossil fuels to renewable energy. To facilitate this transition EU policy will have to be reoriented from realizing incremental changes to realizing transformative changes. One of the sectors that will play a key role in this shift is transportation, and one part of the solution in transportation is electric-powered vehicles, which will need to substitute internal combustion engine cars. EVs require a public EV charging infrastructure. The Dutch case (Case 5) elaborates on that.

In 2009 the number of publicly accessible charging points in the Netherlands was low. The ambition was to have 10,000 of such points in 2013 and 50 (public) fast charging stations (Plan van Aanpak, 2010). Since then, the ambition has been adjusted several times. In 2020 there were almost 40,000 public charging points (and 2,027 fast charging points). The ambition is to have 1,7 mill. charging points by 2030, enabling drivers to charge their EVs in the entire country.

The Netherlands is a clear leader in the EU when it comes to charging infrastructure, suggesting this is a 'best practice'. Other MS are less far in their rollout of public charging infrastructure. By studying the Dutch Case we can learn lessons about how the rollout of public charging infrastructure and the evaluation of public charging infrastructure policies.

The Belgian Case also covers interactions between Belgian direct renewables' support policies and the EU-level policies in which they are embedded, such as the Renewable Energy Directive and its national targets, as well as planning aspects such as the National Renewable Energy Action

[3] More specifically: 20% reduction in the EU's primary and final energy consumption by 2020 compared to the energy consumption projected in the 2007 PRIMES scenario for 2020.

Plans under the RED and more recently the National Energy and Climate Plans and National Long-Term Strategies under the 2018 Governance Regulation.

In the German case, Germany's first start of a large-scale smart meter rollout Potential failure has culminated in a lawsuit and ruling of the Higher Regional Administrative Court in the state of North Rhein Westphalia in 2021, where the court ruled that the competent authority did not sufficiently fulfil the legal requirements when approving smart meters and temporarily stopped the duty to install smart meters. However, the policy approach to have an incredibly detailed regulatory framework in place before developing the technology might help data protection issues and concerns and benefit digitization overall.

The Polish case (Case 6) serves as a basis to identify relevant features and tools for a transformative exit from coal-related investments in the real economy, using the implementation of Article 10c as an example of the Polish opportunities for green transformation. The investigation helps develop options to improve financial institutions' internal procedures, incentives and governance structures for integrating EU ETS into their operations. It reviews and refine the mandates of financial regulators and supervisors to better accommodate the recommendations for a transformative ETS system in the next versions of national regulations for future European climate policies. This case study can act as the basis for a more detailed evaluation of the activities related to the energy transition that are supported by EU ETS money in the future. Considering Poland's inefficient use of the exception granted by Article 10c, it was appropriate to dispense with it for the EU ETS's fourth phase. The Modernization Fund received none of the money made accessible by Article 10c, instead, it was added to Poland's auction pool. Changes should be made to the way these monies are used in light of the fact that auction pool income was also not used efficiently.

In the French case (Case 3) the implementation of this policy happened in a context of rising awareness among financial supervisors and financial institutions that the financial sector can be affected by climate change and the transition to a low-carbon economy, but at the same time banking sector has a role in policy creation and implementation. To keep the financial stability of the country (France in this case) and the EU, several financial supervisors decided to implement climate stress test at the national and European levels to determine if the banks' risk management frameworks were strong enough to face the impact of climate change and the transition. The case is not connected to the particular directive, but Network of Central Banks and Supervisors for Greening the Financial System and European Central Bank financial regulations. Financial regulators implemented several key measures, including a climate stress test, to better assess how banks' assets might be affected by climate change and the transition. It evaluates whether it has allowed them to modify their investing criterion. Depending on the outcomes of the climate stress test, the policy may then have an impact on all economic sectors. The French case study investigates how climatic stress tests affect banks' abilities to address environmental challenges. It evaluates how these exercises allow banks to incorporate climate change at both operational and strategic levels.

The Spanish case study (Case 7) is related to the Energy Taxation Directive (2003/96/EC). Considering that the directive includes among its goals to achieve a low carbon economy it is relevant to assess to what extent the implementation at the MS level has managed to advance in that direction. As the debate is ongoing on the reform of the Directive as part of the changes needed to achieve the new climate goals, this topic acquires increased relevance in terms of providing insights through the ex-post assessment, of what worked well and what did not. While the Finnish case is oriented on EED to efficiency targets.

3. Analysis procedures

All case studies were designed around a similar methodology with adjustments needed for specific aspects of the cases. Briefly, methodology in all cases could be summed up to:

- A methodological clarification related to the concept of the problem in the case study for example – environmental taxes
- Creation of evaluation framework including characteristics of the climate change problem and climate change mitigation policy considering transformative aspect in analyses
- Literature and policy instrument review including legal analysis of EU and MS framework as well as selection and evaluation of policy documents
- Data acquisition and review (including steps like identifying main data sources, identifying main data points, data acquisition, streamlining data, data analysis and interpretation, and deeper qualitative assessment)
- Selection of interviewees and evaluation of policy output
- Complementing the data with expert interviews;
- Analysing results and building content around key questions:
  - How does it relate to the 4i's / for which of the 4i's can it provide insights?
  - What is the relevance of the studied policy intervention(s) for transformative climate policy? How does the case study provide insights into success conditions or failures/risks of transformative climate policies?
  - How is the study's policy intervention related to EU climate policy and the achievement of climate goals?
- Drawing conclusions, and analysing results that should help to derive lessons learned for success factors/enablers as well as risks/barriers for transformational changes.

4. Results

4.1 Belgian offshore wind: Innovation and Investments (Case 1)

The Belgian case study looks at the development of offshore wind in Belgium between 2002-2022, with a focus on the period when the offshore wind parks became operational (2009-2020). The case study maps the actors in Belgian offshore wind and assesses elements related to innovation and investment. The results of the study cover:

- Background and a brief history of offshore wind in Belgium
- Energy governance in Belgium, a federal state with powers divided between the regions and the federal government, with the regions responsible for renewable energy, energy saving, and the distribution of power and gas, and the Federal government responsible for offshore wind energy development.
- The policy framework for offshore wind support in Belgium. In addition to the Marine Spatial Plan that designates the zones dedicated to the development and operation of offshore wind farms, the policy framework consists of three parts: Permitting and domain concessions, guarantees of origin, and green certificates.
- The key findings on innovation related to offshore wind development in Belgium show that there are:
  - An (emerging) innovation ecosystem consisting of actors from the private sector, public sector, and research organisations
  - A strong correlation between the development of offshore wind and related patents by Belgium companies
  - Strong evidence of innovative entrepreneurial activities
  - Evidence of companies changing or adapting their business model
  - Evidence of Belgian developed know-how being exported
  - The emergence of an innovative offshore wind ecosystem in Belgium showed through the mapping of the Belgian offshore wind ecosystem, actors that are relevant to innovation have been identified. Including coordination organisations, research bodies, and entrepreneurial activities.
- There is a correlation between Belgian offshore wind development and patents, as well as evidence of companies changing or adjusting their business model. Key findings on investment are:

- Majority of offshore wind is Belgian owned with a large share of public sector ownership
- Investment banks and in particular the European Investment Bank played an important role in financing Belgian offshore wind to achieve financial closure
- Long-term financial certainty via the support mechanism and Power Purchase Agreements (PPAs) was important in securing investments in Belgian offshore wind. PPA's frequently link to industrial end consumers
- The cost per MW installed has come down between 2009-2020
- Investment banks, such as the EIB, played an important role in financing Belgian offshore wind development. PPA's are also commonly used in Belgian offshore wind, with major industrial companies acting as intermediaries to conclude downstream PPA's. They can be advantageous for the industry due to their long-term supply and pricing stability.

- Prospects for Belgian offshore wind energy where offshore parks can be re-powered to increase production capacity, and the Belgium government is planning to construct an energy island to be an electricity hub for offshore wind and if possible, the offshore wind outside of Belgium.
- Regarding the evolution of investment costs, while all the offshore parks are not exact copies of each other (e.g., different types of turbines, size, distance from shore, and construction depth) a clear evolution in costs is visible.

4.2 Voluntary Energy Efficiency Agreements in Finland (Case 2)

The Finnish voluntary EEAs have delivered targeted energy savings before any legally binding energy efficiency obligation was set by the EU, providing an example of how national existing instruments can be used and adjusted to implement EU climate policies. This case study was conducted to learn from existing policy instruments and national practices what effective climate and energy policies should consider in the future. The study results covered:

- Relevant policies and policy instruments - Voluntary EEAs are the most important policy tool for implementing Finland's Integrated Energy and Climate Plan. Government officials negotiate EEAs for business, government, construction, and the oil industry, with distinct action plans for various industries.
- Energy efficiency targets and results and description of the EEAs.
- EEAs for Municipal Sector and its multiple benefits as an example **-** It is important to communicate energy efficiency measures and the outcomes of their adoption, identify advantages, communicate with one another, and share information with other towns or

actors. Municipalities' vitality reputations are essential for attracting new residents and businesses, and energy-efficiency initiatives encourage collaboration between businesses and citizens.

- Key features of the EEA system:
  - Participating businesses gain a variety of advantages, including financial ones from lower energy use as well as value from being sustainable or climate-friendly.
  - Each business evaluates the advantages on an individual basis before determining if joining the EEA is worthwhile.
  - Key players in teaching and assisting businesses and municipalities in their efforts on energy efficiency are the national authorities.
- These advantages are also the main reasons why participants opt to commit to the energy efficiency measures through the EEAs; when businesses and municipalities recognise the potential of energy efficiency, it engages them freely.
- Challenges identified.

4.3 Climate stress tests in France: what co-benefits can we expect for transition financing? (Case 3)

The case identifies what possible co-benefits climate stress tests may have on transition financing, as well as their limits in this regard. The outcomes are based on an analysis of the initial lessons learned by French banks and supervisors from these exercises. The analysis was conducted following the two exercises in which French banks participated, the pilot climate exercise conducted by the ACPR in 2021 and the prudential exercise conducted by the European Central Bank on eurozone banks in 2022. The main findings consider:

- Climate stress testing has had an important impact on French banks, as it has given credibility to climate issues and strengthened the coordination between their various teams. The more the banking teams are trained and coordinated on climate issues, the more they could potentially be in a position to take decisions in favour of financing the transition. However, this will depend on whether banks can identify financial opportunities or whether regulatory requirements provide incentives.
- The processes of collecting climate data from banks on their counterparties, prompted by the climate stress tests, have been of partial use. These data collection processes have been time-consuming and laborious for banks, and many have had to rely on proxies to provide the required information. However, momentum for data collection has been set in motion and is expected to continue to grow in the future. Environmental Performance Certificates are essential for banks to participate in the financing of the transition in the real estate sector. Nevertheless, GHG emissions data on banks' largest

counterparties have had a limited impact on transition financing, as it is difficult for banks to collect this type of information reliably and does not provide insight into the transition potential or financing needs related to the implementation of the counterparty transition plan.

- The analyses deriving from the modelling exercises also had a limited impact on the ability of banks to finance the transition. They presented numerous difficulties in assessing the impact of the transition in the real economy, and they did not manage to sufficiently grasp the dynamics of the transition and the various risk transmission channels. Yet, for banks to be able to participate in the financing of the transition, it seems very important that they have fully integrated all the specificities of these dynamics, in order to take decisions accordingly.
- Climate stress tests have had a limited impact on banks' climate strategies and decision-making processes, due to lack of reliability, difficulty in demonstrating financial materiality, and lack of binding supervisory measures. It is not clear if additional capital requirements would have a beneficial effect on transition financing by banks.

4.4 Germany's delayed electricity smart meter rollout (Case 4)

The EU must digitalise its energy systems and facilitate the electrification of its economies to achieve climate neutrality by 2050. Smart energy grids combine energy production, storage, and consumption, and smart metering systems serve as intelligent communication technologies. The EU first mandated its Member States to roll out smart meters back in 2009, but Germany lagged far behind. An ex-post analysis revealed that the German smart meter implementation was delayed and not a successful transformational method due to a lack of regulatory action, an overregulated market, and a poor governmental framework. Five semi-structured interviews with field stakeholders confirmed the findings. The results included:

- European legal framework provides leeway to Member States by setting a minimum set of technical requirements for smart metering devices
- German legal framework first leaves technological diffusion to the market. In the later phase, we can observe how overregulation and a weak governance framework slow down innovation and impacts the creation of infrastructure, the integration of smart meters into the energy systems, and social acceptance.
- 2005 - 2012: Lack of regulation leaves technological diffusion to the market. A lack of regulatory intervention in the period 2005 – 2012 in Germany's stance at kick-starting its smart meter rollout created uncertainties among market players. In other words, due to both unclear guidelines and standardised technological requirements, the market alone was unable to foster technological diffusion.

- 2013 - 2019: Overregulation leads to technical complexity and paralyses large-scale rollout. The German government implemented a complex smart metering system in 2013 to meet the EU's minimum technical requirements and data protection measures. Three independent manufacturers developed devices that met the technical requirements, and the system was implemented on the ground.
- 2019 – 2021: Unlawful certification halts rollout. The German smart meter rollout began in February 2020, but it was a late start compared to other EU MS. Overregulation slowed down the rollout, and in 2021, the High Administration Court of North Rhein-Westphalia ruled that the Federal Office for Information Security (FOIS) had unlawfully published the market declaration of three independent manufacturers.
- Beyond 2021: An amended policy to accelerate the rollout. The FOIS simplified the standardised technical guidelines, but the German federal government did not have the competency to implement them, delaying the smart meter rollout. In 2022, an amended MPOA was adopted, allowing for a re-start of the rollout.
- The German government did not design a transformative rollout for smart metering systems, and without the right infrastructures, they become less attractive to end users. The analysis of the German legal framework showed that interoperability, the technical feature that allows sector coupling and empowers end consumers to participate in the energy transition, was not implemented by smart meter developers. With the rise of renewable energy sources and decentralised energy models, the integration of smart meters into the sectors of mobility or heat and cooling provides great potential to reduce fossil-based energy production and reach climate neutrality by 2050.

4.5 The rollout of public charging infrastructure for electric vehicles in the Netherlands (Case 5)

This case study presents a framework to evaluate Dutch public policies for the rollout of (semi)public charging infrastructure for EVs in the period 2009-2020. The framework is structured using the Adjusted-TIS framework and the linear innovation model. The experts identified 61 obstacles that were encountered, and policies of the central government contributed to solving about half of them. Large municipalities and Elaad foundation were also important for the rapid rollout of the infrastructure. Results included:

- *The period 2009 – 2012: Proof of concept and experimental phase*: The most important obstacle to overcoming the lock-in effect between a lack of EVs and public charging infrastructure. Elaad was instrumental in installing the first 3,000 public charging points in the Netherlands, while the central government provided financial incentives to reduce the total costs of ownership of EVs. The central government also made a €65 million investment in the EV sector to stimulate the economy during the Great Recession but made few policies directly relating to public charging infrastructure.

- *The period 2012 – 2015: Pilot and demonstration phase:* The key challenges for the implementation were a lack of fundamental institutions and (informal) infrastructure to support a sizable market for public charging infrastructure. The central government's policies, such as those that supported research on market structure for public charging infrastructure, made it easier to overcome these barriers. Nonetheless, businesses and significant metropolitan municipalities' self-regulation accounted for a significant portion of the innovation power.
- *The period 2015 – 2020: Upscaling phase:* The challenges start to differ depending on the region. While the market for public charging infrastructure in certain (urban) regions had grown very mature, it was almost non-existent in other (rural) places. At this time, the central government helped (smaller) towns roll out public charging infrastructure, among other things by providing (limited) financial support, although the municipalities handled the bulk of the work themselves.
- *Beyond 2020:* Some of the long-anticipated challenges began to materialise. These challenges are brought on by the rapid expansion of EVs and the wider electrification of the economy, which raises concerns about human resources and the capacity of the electrical grid. By this time, it also became apparent that the federal government's goals for EVs had changed from focusing on economic issues (as they had in 2009) to addressing climate change. In policy papers, bringing EVs to lower-income households and gradually phasing out automobiles with internal combustion engines take on greater importance.

4.6 The impact of the EU ETS revenues and derogation 10c on investment and infrastructure in Poland (Case 6)

The Polish case study looks at how Poland's infrastructure development and investment levels are impacted by two types of EU ETS funding: Derogation Article 10c and auction earnings. Although Poland's actions raise questions about whether the Directive is being followed, auction proceeds must be utilised for energy transition programmes. As the generating market was consolidated and reported investments were concentrated on expanding conventional producing capacity, the derogation mechanism was not future proof. Case results are summarised below:

- Polish media monitoring and analysing Trade Magazines/Journal Articles revealed 24 webpages publishing information regarding EU ETS and article 10c were found. Most of the published information (37,5 % of all webpages) came from the portal of NGOs or analytics with an environmental or energy focus, second source were regulators (16,65%; The National Centre for Emissions Management (KOBiZE) and Energy Market Information Centre (CIRE) and public administration (16,65%; including parliamentary team). Information was also available on legal portals (12,5%), in daily business news (12,5%), and once communicated by a Polish press agency (4,2%).

- The key features and assumptions behind the two investment mechanisms we investigated. It should be noted that auction revenues and Article 10c are substantially different: they have different direct beneficiaries (the state and electricity producers respectively), differently defined catalogues of activities, and are also differently managed at the EU level. The quantity of allowances utilised under Article 10c decreases the pool of auction allowances, which would otherwise rise. Although auction proceeds may be used to help the decarbonization of the electrical sector, which typically accounts for the majority of the economy's emissions, the two activity catalogues overlap. The study must first define the goals of the two investment mechanisms, as specified in the ETS Regulation.
- The use of the funds from the auction of the national pool of allowances is rather simple; the non-earmarked proceeds go into the budget, and their immediate use is subject to whatever restrictions and other arrangements the Member State may see appropriate. The Polish example is intriguing because, of all the MS, Poland had the largest eligibility for financial help under Article 10c, yet it forfeited a sizable portion of it. The Polish government cites this as the cause as some of the projects included in the National Investment Plan were never finished, making it impossible to strike a balance between the expenses associated with qualified investments and the emission allowances that were intended to be awarded. The public administration claims that businesses frequently abandoned the investments mentioned in the National Investment Plan because they were unprofitable, which led to the auctioning of the emission allowances that had not been given to power providers.
- Expert survey with outcomes mainly supporting the findings of the secondary data analysis. The auction pool of permits has issues with additionality, eligibility, and openness, and policies did help to reduce carbon emissions, but only somewhat. According to one responder, the exception under Article 10c was improperly applied and accelerated decarbonization.

4.7 The role of energy and environmental taxes in Spain (Case 7)

This case study investigates the introduction of energy and environmental taxes in Spain from 2005 to 2020 and their contribution to reducing climate change. Despite the EU's support, MS' implementation of them varies widely due to a lack of coordination and jurisdictional complexity. The case highlights concerns about how well EU legislation harmonises environmental taxation, the efficacy of environmental taxes, how they are distributed, how jurisdictional levels play a role, and damaging subsidies. Results of the Spanish case include:

- The case examines the role of EU legislation in shaping the environmental tax system in Spain. It assesses the characteristics of the instruments and regulations related to the harmonization of environmental taxes in the EU, as well as how the regulations have

emerged. The Energy Taxation Directive (ETD) from 2003 has influenced the definition and reformulation of environmental tax instruments in Spain. A new ETD proposal has been proposed, but further work is needed to reach an agreement. The shortcomings of the harmonization and regulation of environmental taxes by the EU have left the use of these instruments largely at the will of each MS.

- Energy and Environmental Taxation in Spain including different existing energy and environmental taxes and their impact from an environmental perspective is assessed and presented according to the classification below:
  - Central government
    - Special tax on certain means of transport (IEDMT)
    - Excise tax on hydrocarbons
    - Excise duty on electricity
    - Excise duty on coal
    - Special tax on the value of electricity production (IVPEE)
    - Tax on the production of spent nuclear fuel and radioactive waste resulting from nuclear power generation.
    - Tax on the storage of spent nuclear fuel and radioactive waste in centralised facilities
    - Charge for the use of inland waters for the production of electricity.
    - Tax on fluorinated greenhouse gases
    - Tax on motor vehicles (IVTM)
  - Taxation from autonomous regions is divided into five categories: atmospheric emissions, installations and activities that affect the environment, wind energy taxes, dammed water, and hydrocarbons. These taxes have a significant revenue-raising weight, but their role in regional tax revenues is marginal.
  - Reform proposals by expert commissions including distributional effects, where compensatory alternatives for the distributional impacts of energy-environmental taxation are presented.
  - The role of harmful subsidies in the Spanish energy and environmental tax system.

5. Conclusions and future work

5.1 Belgian offshore wind: Innovation and Investments (Case 1)

The case shows how broad and diverse the Belgian offshore wind ecosystem came into life and how Belgium has become a global player in the construction of offshore wind parks and infrastructure. Conclusions from the case study are presented below.

The large market shares of offshore wind in Belgium are due to the early development of the sector, which allowed large and multinational Belgian companies to invest in technologies and techniques. Maritime engineering companies invested in innovative offshore wind construction and maintenance ships and held a large share of offshore wind-related patents. This continued innovation allowed them to engage in larger offshore wind construction outside of Belgium and Europe. Offshore wind energy is still a capital-intensive business, and completing offshore wind projects financially and getting the funding remains a significant hurdle. Three components from this case study assisted in making the required investments:

- Green energy certificates used in the Belgian support system provide a reliable income stream over the long run and have been modified to respond to the decreased costs of offshore wind energy. Offshore wind projects are also facilitated by infrastructure, such as offshore to onshore cables.
- Offshore wind received significant finance (loans) from multilateral development banks, particularly the European Investment Bank. Access to capital from private banks was made easier by the existence of such substantial and reliable banks.
- These projects received an additional degree of financial certainty by having income streams secured by (long-term) power purchase agreements. What's interesting is how offshore wind benefits energy-intensive sectors in a symbiotic relationship. PPAs because they (depending on the arrangement) maintain prices while reducing indirect greenhouse gas emissions.

The findings of this case study only relate to Belgian offshore wind, making it difficult to extrapolate to other nations and industries. However, the suggestions for transformational policies are more comprehensive and take local conditions into account. This mapping may be replicated for other offshore wind-using nations, allowing for a comparative study and more generalised findings. Such a comparative analysis might be a part of future research based on this case study. Since the presented examination of the innovation system's actors is a prerequisite for it and a case study can serve as its foundation.

5.2 Voluntary Energy Efficiency Agreements in Finland (Case 2)

The EEA system in Finland has been successful in delivering energy savings and promoting energy efficiency measures at different levels and sectors. It involves different ministries and authorities negotiating with trade associations on targets and measures for different sectors. Companies and municipalities are represented in the negotiation phase and the starting point for engaging many actors in a sector to energy efficiency work is demonstrating the multiple benefits of energy efficiency. Voluntary EEAs are open for any organisation to join and have been successful in providing participants with first-hand experience on energy efficiency measures. This has enabled effective communication and a wide exchange of information, potentially triggering new initiatives in other companies. The case study findings are presented below:

- To encourage additional participation and energy efficiency measures, it is crucial to communicate the possibilities of energy efficiency. By actively teaching and training people, both in businesses and the general public, about energy efficiency and sustainable choices, the competent authorities also give substantial assistance to participants in finding and putting into practice the potential measures. This encourages education and training on its behalf to guarantee the availability of information and skills for the changeover.
- Voluntary EEAs have been successful in Finland and may provide some aspects to consider for further design of policies and policy instruments. These include creating a low hierarchy network, involving stakeholders in designing the instrument and respecting their needs, and integrating policies and requirements in one flexible instrument. However, in some MS it has been more successful to take obligations directly in the law. These cultural differences should be cherished if EEAs are to achieve the long-term goal of climate neutrality.
- National characteristics should be recognised when designing and drafting climate policies, allowing MS to develop their existing policy instruments. Finland's energy efficiency obligation scheme, enshrined in Art. 7 EED, should be recognised and utilised in the transition towards net zero.
- The EEAs can include new industries, players, and needs in the framework, allowing for a wider approach to combine policies with a climate neutrality target, making their implementation more compelling. Existing good practices can be used to design transformative climate policies, but a more comprehensive analysis and comparison of existing practices in the nine MS that have introduced some sort of voluntary EEAs should be done. It is also important to map the key characteristics in each system and see which ones have generally proved significant.

5.3 Climate stress tests in France: what co-benefits can we expect for transition financing? (Case 3)

The case study outlines the potential advantages and limitations of climatic stress assessments concerning transition funding. Nevertheless, the report does not examine whether the initial goals established by the supervisors for the climate stress testing have been met. Conclusions are presented below:

- Climate stress tests have made it possible to integrate climate issues into the organisational and governance processes of banks, but have had a limited impact on transition financing. To do so, banks must incorporate environmental considerations into their decision-making processes and use the right tools to respond to these processes. It is doubtful that climate stress tests will ever be used as a financial regulatory instrument that will assist the EU in achieving its climate objectives based on the findings of this study and earlier work done inside I4CE.
- As a consequence, stress tests should be accompanied by other instruments that allow banks to better understand the transition dynamics of their counterparties in order to better support them in the transition. Banking transition plans could be an effective solution as they rely on banks' counterparties' transition plans and allow them to better understand how they can accompany their counterparties. These plans could fill in the missing pieces needed to provide transition financing and play an active part in the quest for an orderly transition. They expect to become publicly available as early as 2024 or 2025.
- The study's findings do indicate that the inclusion of required banking transition plans can circumvent the drawbacks of climatic stress assessments in transition funding. I4CE has decided to concentrate its future study on this subject because banking transition plans were selected as the focus of the ex-ante impact assessment inside the 4i traction project (WP4) relating to the Investment element.

5.4 Germany's delayed electricity smart meter rollout (Case 4)

The case study investigated the factors that contributed to the delayed German smart meter rollout by conducting an ex-post analysis of the European and German legal frameworks for a smart meter rollout, in the years 2005-2021 and beyond. It found that the German government took a market-led approach to technological diffusion, but that the market alone could not foster a large-scale smart meter rollout. Technical complexity as a consequence of technical requirements that were hard to meet by developers was a key factor in Germany's delayed rollout. The EU gave leeway to MS by only setting minimum technical requirements for the development of smart metering devices, but Germany took the 'design by data protection' to heart. The

introduction of 'less smart' metering systems – as seen in Italy and the Netherlands - can help foster technological development and increase social acceptance, which are key aspects in achieving the mainstreaming of new technologies. Results are shown below:

- The German approach to a large-scale smart meter rollout was not transformative in terms of innovation, infrastructure, integration, and social acceptance. The analysis of the German legal framework showed that interoperability, the technical feature that allows sector coupling and empowers end consumers to participate in the energy transition, was not implemented by smart meter developers. To foster technological diffusion, governments should provide clear guidance to relevant stakeholders and provide supporting regulations with regard to technical requirements.
- Policymakers should monitor the rollout of transformative innovations more closely and react in a fast and flexible way to signals from the ground. The FOIS amended the policy even though it did not have permission, and it took the central government one year and a half to announce a re-start of the smart meter rollout. To meet the Paris climate agreements, policymakers should react immediately to signals that a rollout of an important technology is not progressing sufficiently fast, as a 'wait and see' attitude leads to unnecessary delays.
- Governments should provide a strong governmental framework for transformative policy, but the German smart meter rollout was hindered by a lack of cooperation between the FOIS and the central government. To avoid unnecessary costs and increase social acceptance, smart meters should be easily and cost-effectively upgraded.
- This case study shows that to achieve climate neutrality by 2050, policymakers must take a transformative approach and address the core challenges of innovation, infrastructure, integration, and social acceptance. Future research should include investment needs and costs related to a smart meter rollout, as well as the digitalisation of energy networks and the extension of supporting infrastructures.

5.5 The rollout of public charging infrastructure for electric vehicles in the Netherlands (Case 5)

This research uses the Adjusted-TIS framework and the linear innovation model to evaluate Dutch public policies for the deployment of (semi)public charging infrastructure for EVs in the years 2009 to 2020. The findings suggest that the central government's actions are insufficient to explain the Netherlands' quick adoption of the infrastructure, which was also largely driven by large municipalities and Elaad foundation. The case study offers a number of interesting reflections on transformative climate policies which are summarised below:

- Consider involving the public sector in private sector activities in the early stages of a transformative innovation

- Use tenders in combination with sub-national governments as an effective innovation strategy
- Let legislation follow innovation and use self-regulation in the early stages of innovation
- Avoid resistance by rolling out transformative innovations in areas that have few incumbent industries
- Cost-effective innovation by focusing on (non-financial) TIS-functions and public-private cooperation
- Organise compensation for first-mover disadvantages related to innovations in crucial infrastructure technologies with large network externalities.
- Explore if it is fruitful to analyse the rollout of public charging infrastructure after 2020 as a merit good rather than an innovation.

5.6 The impact of the EU ETS revenues and derogation 10c on investment and infrastructure in Poland (Case 6)

The Polish case study constitutes an analysis of two streams of funds for investment in low-carbon transformation, including investments in energy infrastructure, under the EU ETS. Findings demonstrate that the mechanisms themselves had several shortcomings that affected the possibility of optimal and efficient spending. Conclusions from the case study and findings are shown below:

- Both two methods did not significantly contribute to the advancement of low-carbon energy sources. This is demonstrated by the small amount of money allocated for this purpose or the fact that the money received from the auction was invested in already-existing support systems (without the additionality effect). The funding also provided only a small amount of help for the energy transition, for example, through infrastructure expansions and renovations.
- Furthermore, Poland has been preparing to implement a special fund known as the "Energy Transformation Fund" for a number of years. This fund would be funded by EU ETS allowances. The legislation introducing the Exchange Traded Fund, however, is still pending at the legislative training's opinion stage.
- Given that Poland has ineffectively used the exemption under Article 10c, it was reasonable to renounce it for the fourth phase of the EU ETS. The money made available by Article 10c was put into Poland's auction pool; none of it went to the Modernization Fund. Since that revenue from the auction pool was also not used effectively, changes should be made to how these funds are handled.
- In light of this, it is necessary to enhance the distribution of auction revenues in order to increase effectiveness. To do this, the proposed Exchange Traded Fund, which would be

entirely financed by auction revenues and used to make investments and support projects for the energy transition, must be launched.

5.7 The role of energy and environmental taxes in Spain (Case 7)

The Environmental Tax Directive (ETD) was limited to energy taxes and the environmental purpose played only a minor part in its execution. Exclusions to certain industries or technologies were used to maximise its environmental potential, but the failure to adjust tax rates since its implementation in 2003 has reduced its environmental impact. The current revision of the ETD addresses some of the major issues by connecting the rates to each product's environmental effect and developing an automated process to adjust prices in line with inflation. However, environmental taxes outside the ETD's purview have not been further harmonised, as seen in Spain. The investigation used in the case study produced the primary findings shown below:

- Environmental taxation rates in Spain have been among the lowest of all EU MS from 2005 to 2021, but their environmental effectiveness is limited due to the scope and instrument design. Taxes are primarily revenue-generating and have little potential to influence behaviours toward more ecologically responsible ones.
- The undesired negative social effects of environmental taxation are assessed, with a focus on the most vulnerable segments of society. The effects of various energy and environmental taxes on various demographic segments in Spain were investigated, showing that a successful and equitable transition to a decarbonised economy depends on the establishment of distributive compensations using the money raised by energy-environmental taxes. These compensations should be directed to homes that are disproportionately impacted.
- One of the biggest obstacles to I - integration is the coordination and coherence of many authorities. The inherent complexity of coordinating a sizable number of organisations, each with distinct political and social goals, appears to be a contributing factor to gaps in this area. However, it also didn't appear that the central government had a clear intention to use these instruments and look for coordinated action with the regional governments during the review period, and neither did the regional governments appear to have a clear intention to look for coordination among themselves.
- Another important aspect that the case has revealed is the potential conflict among instruments targeting to mitigate different externalities. The example of taxes targeting the visual impact of wind energy infrastructure can put this technology in a disadvantaged position compared to more polluting solutions from an emissions perspective. Therefore, better coordination and better policy design are needed to try to mitigate these undesired effects.

- Improved coordination and policy design are needed to reduce externalities such as taxes that target the aesthetic impact of wind energy infrastructure, which can disadvantage this technology in terms of emissions.

5.8 General conclusions and comparison of findings across the Case Studies

The results of the NCS should be taken into account in three different ways: as operationalization and examples of methodology to be replicated in other cases in the 4i's framework; as general recommendations regarding policy assessment performed in diverse MS in various ways; and as a source of general and specific findings for each "I" (innovation, investment, infrastructure, and integration).

5.8.1 Frameworks and proposed methodology for transformative assessment in all 4i aspects created in NCS

The **Innovation** challenge looks at many forms of innovation and how they could help the EU become carbon neutral by 2050. This also requires going beyond technology innovation to take into account both business model innovation and policy/governance innovation because the transition to carbon neutrality is a systemic problem. Innovation examples in the NCS: offshore wind – BE (Case 1) and public charging infrastructure for EVs – NL (Case 5).

The **Investment and Finance** challenge is focused on the identification and growth of climate-friendly investments. Beyond the sectoral approaches currently pursued in financial regulation, the Investment and Finance challenge should adopt a more detailed and granular perspective and explore its implications. Investment examples in the NCS: offshore wind – BE (Case 1), transitioning financing and banking – FR (Case 3), and evaluation of the impact of the EU ETS revenues and derogation 10c – PL (Case 6).

The **Infrastructure** challenge is essential to achieving the long-term climate goals of the EU as well as other important EU goals like ensuring the security of the energy supply. The problem is complicated by a number of developments, including shifting patterns of energy production and demand for energy as well as shifting patterns of transportation and mobility for transportation infrastructure like roads, trains, and waterways, all of which must be climate neutral. Infrastructure examples in the NCS: public charging infrastructure for EVs – NL (Case 5) and electricity smart meter – DE (Case 4)

Integration is the connection of various sectors through technology solutions. Climate policy integration is the systematic integration of climate policy objectives across multiple sectors. Integration examples in the NCS: voluntary Energy Efficiency Agreements - FI (Case 2) and the role of energy and environmental taxes - ES (Case 7).

In addition to identifying and describing policy gaps, trade-offs, and conflicts in achieving climate goals, work on seven national cases and a summary in the NCS helped identify the important contributing elements for achieving the EU's 2020 energy and climate targets, identifying the case studies' main areas for political interventions, leveraging those points to guide future policy, and elevating the evaluation to a thorough analysis using the 4i concept.

5.8.2 General recommendations for policy assessment in the cases

The findings of this case study only relate to a particular MS and case, making it difficult to extrapolate to other nations and industries (e.g. other than Belgian offshore wind or smart meter rollout in Germany). **However, the suggestions for transformational policies are more comprehensive and can be replicated for other nations using similar infrastructure, innovations, policy instruments, and tools. National characteristics should be taken into account when designing climate policies, such as Finland's energy efficiency obligation scheme for EEAs.** For example, the instruments considered in the cases such as EEAs can be used to combine policies with a climate neutrality target, but a more comprehensive analysis and comparison of existing practices is needed. Key characteristics in each system should be mapped and identified.

The outcomes of NCS presented as the background in the cases could be used in other studies. Recommendations regarding particular instruments and "I" in the case studies can be based on a comparison of MS' situation in the studied areas and policies.

5.8.3 Recommendations for each of the "I"

Finding for **Innovation** from three various cases conducted for the "I" are complementary. Namely, some instruments, such as green energy certificates for offshore wind energy in Belgium, provide a reliable income stream and are modified to respond to decreased costs of energy, facilitated by infrastructure in MS (details in offshore wind, BE, Case 1). This was generally confirmed by the outcomes of the Dutch case for public charging infrastructure for EVs (details in Case 5) without implicating a particular financing instrument but by presenting more general observations regarding legislation that follows innovation and uses self-regulation in the early stages of innovation. **It is recommended to avoid resistance by rolling out transformative innovations in areas that have few incumbent industries**. Another aspect is the phase-out of previous technologies and social justice, which have increased the importance of innovation.

Policymakers should monitor the rollout of transformative innovations more closely and react in a fast and flexible way to signals from the ground to meet the Paris climate agreements. For example, in the German case (electricity smart meter, DE, Case 4) the FOIS amended the policy even though it did not have permission, and it took the central government one year and a half to announce a re-start of the smart meter rollout.

Investment gathered the majority of recommendations and was regarded as direct or indirect in all cases. Surprisingly, considering the variety of case types, the unique characteristics of the studied cases, the various national laws and regulations, as well as the case's prominence as an "I" and its suitability as a good or bad example of the practice within "I," all MS's conclusions were consistent.

Innovative infrastructure received finance from multilateral development banks and private banks, making access to capital easier in Belgium (details in offshore wind, BE, Case 1). While innovative projects benefit energy-intensive sectors through power purchase agreements, which maintain prices while reducing greenhouse gas emissions in Belgium. Similarly in the Netherlands, where it was highlighted how important is organising compensation for first-mover disadvantages related to innovations in crucial infrastructure technologies with large network externalities and proposing cost-effective innovation by focusing on (non-financial) TIS-functions and public-private cooperation (details in NL, Case 5).

Interestingly also cases 3, 4, and 6, which would not be classified as the best practices regarding Investments, recommend similar solutions as cases 1 and 5. In the case of Transitioning financing and banking (details in FR, Case 3) banks have been able to incorporate climate challenges into their organisational and governance procedures thanks to climate stress testing, but their influence on transition funding has been rather limited. **It should be accompanied by other instruments to help banks understand the transition dynamics of their counterparties and build their transition plans**. It is also not likely that other MS would try stress tests. In case 4, the German smart meter rollout was hindered by a lack of cooperation. To avoid unnecessary costs and increase social acceptance, smart meters should be easily and cost-effectively upgraded. As for the Evaluation of the impact of the EU ETS revenues and derogation 10c (PL, Case 6) it is **necessary to enhance the distribution of auction revenues in order to increase effectiveness. To do this, the proposed Exchange Traded Fund, which would be entirely financed by auction revenues and used to make investments and support projects for the energy transition, must be launched.**

Infrastructure was often mentioned together with Investment and Innovation, only the Dutch case provided direct findings regarding this "I". When focusing on cutting-edge software, artificial intelligence, data monitoring, and remote sensing pertinent to the development, operations, and maintenance of innovative technology, there is strong evidence for **innovative entrepreneurial activities related to infrastructure** (offshore wind in Belgium, Case 1). Also, **instruments like EEA showed a cost-efficient way to develop the energy infrastructure** (details in FI, Case 2).

The contractionary effect was obtained in the scenario with the infrastructure ineffectively supported in the case (details in PL, Case 6) when derogation under Article 10c may have been granted for the following five types of eligible investments: retrofitting of infrastructure, upgrading of infrastructure, clean technologies, diversification of energy mix, or diversification of sources of supply. **The outcomes indicate that in terms of infrastructure, funds were dedicated to**

the expansion of transmission infrastructure. The funds also gave minimal support to the energy transition, e.g., through infrastructural upgrades and expansions.

The specific recommendation would be to consider involving the public sector in private sector activities in the early stages of transformative innovation and use tenders in combination with sub-national governments as an effective innovation strategy (details in NL, Case 5). However, policies such as tax breaks for EV owners could reduce government funding in that area. Therefore, **it is more important to examine public infrastructure as a merit good rather than an invention**.

Integration was an area in which all cases obtained reliable consistent conclusions and suggestions. Outcomes of the cases (e.g. Voluntary EEAs have been successful in Finland) may provide recommendations for further design of policies and policy instruments. These include creating a low hierarchy network, involving stakeholders in designing the instrument and respecting their needs, and integrating policies and requirements in one flexible instrument. However, in some MS it has been more successful to take obligations directly in the law. These cultural differences should be cherished to achieve the long-term goal of climate neutrality.

It is important to communicate the possibilities of energy efficiency and provide assistance to participants in finding and putting into practice potential measures. This encourages education and training to ensure the availability of information and skills for the changeover (details in FI, Case 2). Also, the role of energy and environmental taxes in the EU and particular MS. Where they can be used as distributive compensations but to play their role and be a systematic solution to ensure a successful transition to a decarbonised economy those should be directed to homes that are disproportionately impacted (e.g. in ES, Case 7).

The complexity of coordinating a large number of organizations, each with distinct political and social goals, is a major obstacle to I-integration. However, the central government lacked a clear intention to use taxing instruments and look for coordinated action with the regional governments during the review period (e.g. in ES, Case 7). This was also true for the Belgian case postulating to improve coordination and policy design to reduce externalities such as taxes targeting the aesthetic impact of wind energy infrastructure. Such taxes can disadvantage this technology in terms of emissions. **The potential conflict between instruments to mitigate externalities, such as taxes targeting the visual impact of new energy infrastructure was highlighted. Better coordination and policy design are needed to mitigate these effects** (details in ES, Case 7).

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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, 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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