MIND THE GAP:

ALIGNING THE 2030 EU CLIMATE AND ENERGY POLICY FRAMEWORK TO MEET LONG-TERM CLIMATE GOALS

For a better coordination of climate and energy policies through the regulation on the Governance of the Energy Union

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INTRODUCTION | CONTEXT OF THE REPORT

Negotiations on the EU 2030 climate and energy framework are the opportunity to implement Paris Agreement's goals in the EU

Context:

- **2018 Facilitative Dialogue :** It aims at taking stock of collective efforts towards the long-term goal, and in particular could be the opportunity to rethink climate ambition in the EU
- **Negotiations on the 2030 EU Climate and Energy Framework:**
  - **EU ETS sectors** : Revised EU ETS directive promulgated in March 2018
  - **Non-ETS sectors:** An agreement between EU institutions was also reached in December 2017
  - **EU 2030 Clean Energy Package**: Trilogue negotiations on proposals for energy efficiency, renewable sources of energy and the Governance of the Energy Union started in February 2018. An agreement was found on the renewable energy directive on 13 June 2018, next trilogue on the Governance regulation takes place today
- **Preparation of long-term low-emission strategies**: The preparation of long-term strategies in the EU and at the international level feeds into the revision of the mid-term policy framework

This climate brief was produced in collaboration with Enerdata, within the framework of the research project COPEC II (COordination of EU Policies on Energy and Climate by 2030), launched in April 2017

It follows the publication of a first COPEC II report on the reform of the EU ETS for its Phase IV (2021-2030), which concluded that:

- As currently negotiated, the EU ETS trajectory is **not aligned to the EU long term climate ambition**
- **Counterproductive interactions** undermine the energy and climate policies' efficiency and the agreed reform of the EU ETS will not be sufficient to mitigate overlapping effects of other policies on the EU ETS

Defining an integrated climate and energy framework to meet EU long-term climate ambition

Objective of the study:

To feed-in the EU 2018 negotiations on the 2030 climate and energy framework and the review of the mid-term climate strategy, this climate brief provides:

- **An analysis of interactions between EU energy and climate policies**. The analysis is carried out on historical data (2005-2015) and on projections until 2030;
- **Policy options on how to better align policies to mitigate counteractive interactions** and meet an increased EU long-term climate ambition in line with the Paris Agreement.

- This report provides a **mapping of interactions** and a **first quantitative assessment** of **ex-ante** and **projected** interactions, with two distinct methodologies:

Index decomposition analysis (LMDI)	Modelling of energy systems with POLES
• To provide a **quantification of the contribution of different drivers to the variations in GHG emissions** over the 2005-2015 period	• To analyze the **interactions between EU climate and energy policies** until 2030; • Evaluate the impact of different EU climate and energy targets on the **evolution of energy systems and on GHG emissions reductions**; • Understand the impact of an **“alignment” of the policy package**.

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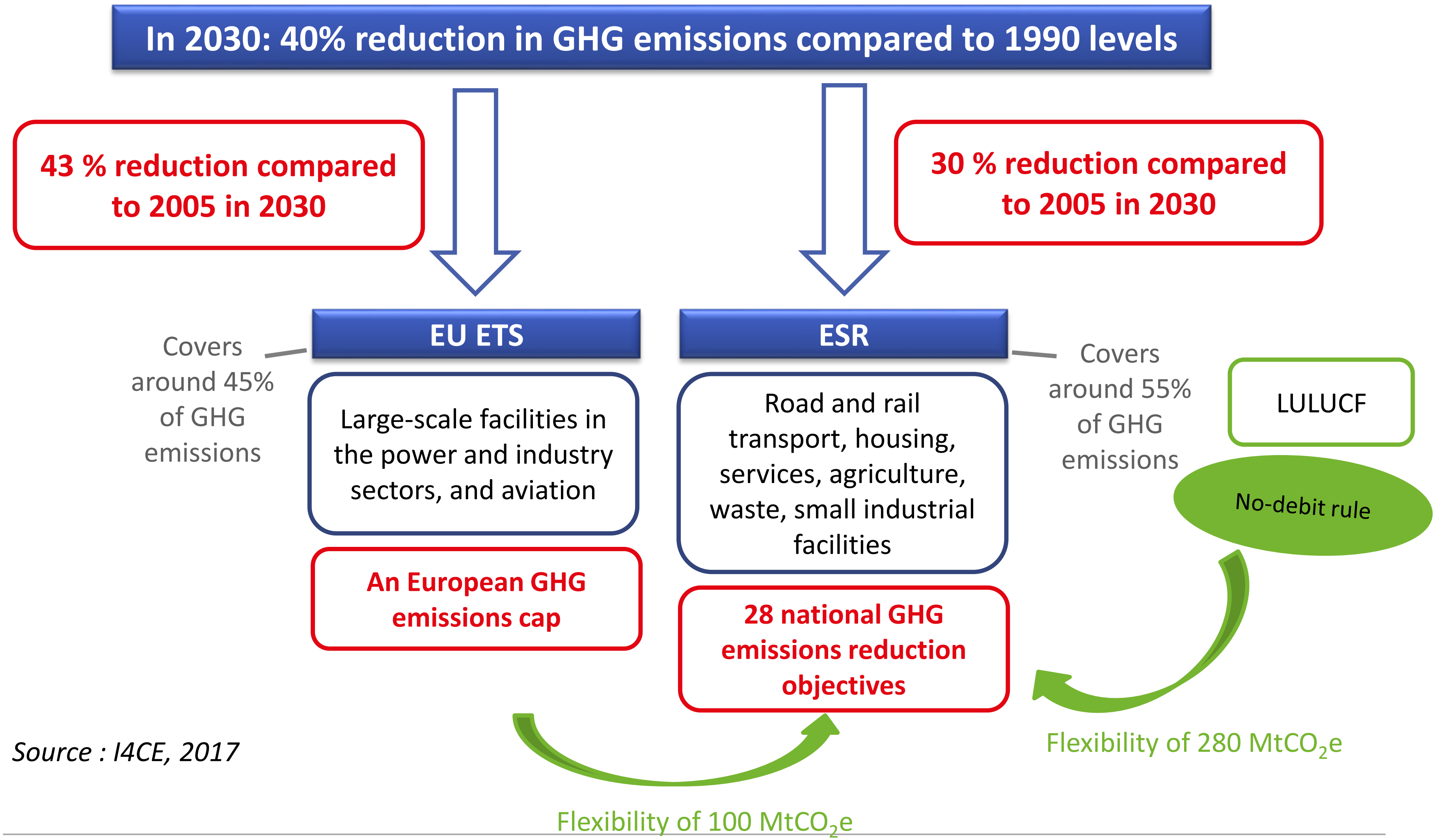
1 | THE EU ETS AND THE ESR

The 2030 GHG emissions reduction target is split between the EU ETS and the ESR



Source : I4CE, 2017

Note: LULUCF stands for "Land Use, Land Use-Change and Forestry".

1 | THE EU ETS AND THE ESR

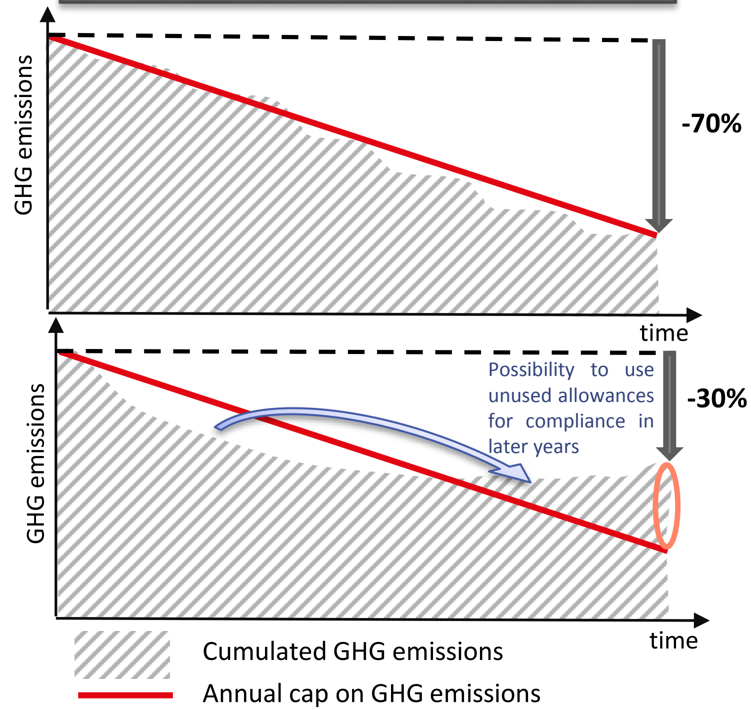
An accurate calibration of the EU ETS and the ESR is required to achieve climate targets

- The EU ETS and ESR, as they respectively allow the carry-over of allowances and AEAs over the period, define **carbon budgets**:

  → The “carbon budget” approach creates some uncertainty: the compliance with the EU ETS and with the ESR **does not ensure the achievement of the EU’s NDC by 2030**

- The carbon budgets defined by the EU ETS and the ESR should be calibrated accurately:
  - The carbon budgets defined by the EU ETS and the ESR should be **consistent with long-term global climate goals;**
  - This calibration should be done as soon as possible before 2030, using **all possible windows offered by the Governance regulation timeline and other review processes;**
  - The carbon budgets defined by the EU ETS and the ESR should be calibrated so as to **limit the formation of surplus** in order to achieve 2030 climate target.

Illustration : a policy instrument defined as a carbon budget does not ensure a given reduction in GHG emissions in a specific year



In this illustrative situation, a policy instrument defined as an annual cap on GHG emissions is implemented, with the possibility to carry-over unused emission allowances. **In both cases, the constraint on GHG emissions defined by the policy instrument is respected** : cumulated GHG emissions are lower than the cumulated cap on emissions. In the case at the top, GHG emissions are in the last year 70% below their reference level, while they are only 30% lower in the case at the bottom.

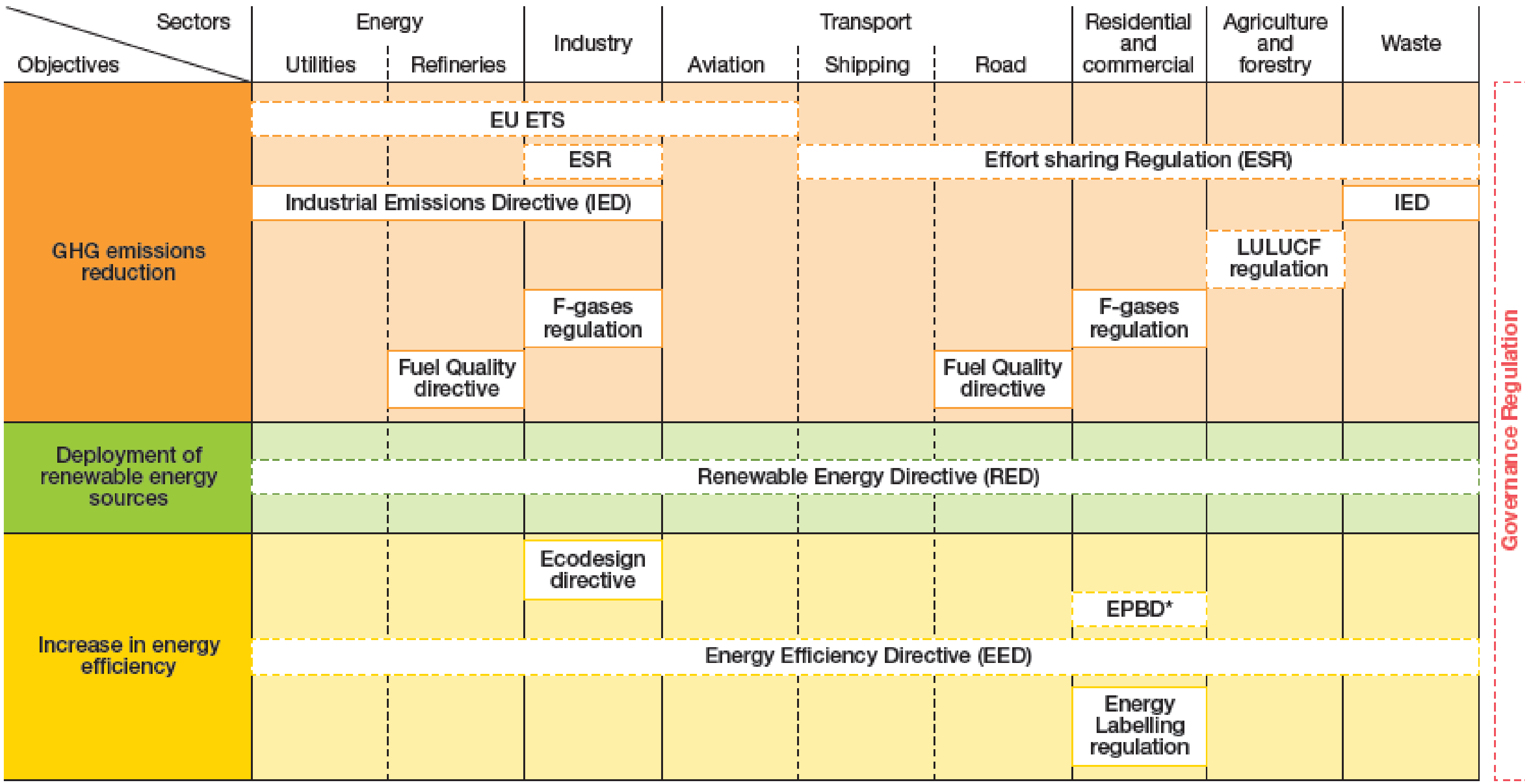
Source : I4CE, 2018

2 | Analysis of interactions in the climate and energy framework

2| ANALYSIS OF INTERACTIONS

Mapping EU legislations in the 2030 climate and energy policy framework

EU legislations in the 2030 climate and energy framework are strongly interrelated: several legislative texts apply to each sector and several texts aim to achieve each EU objective



Legend: *In revision or revised as part of 2030 climate and energy framework* | *In force*

* EPBD: Energy performance of buildings directive

Interpretation of the graph: The different objectives in the left-end column are to be achieved through the legislative texts in the frame with the same color. Those legislative texts apply in the sectors in the respective columns.

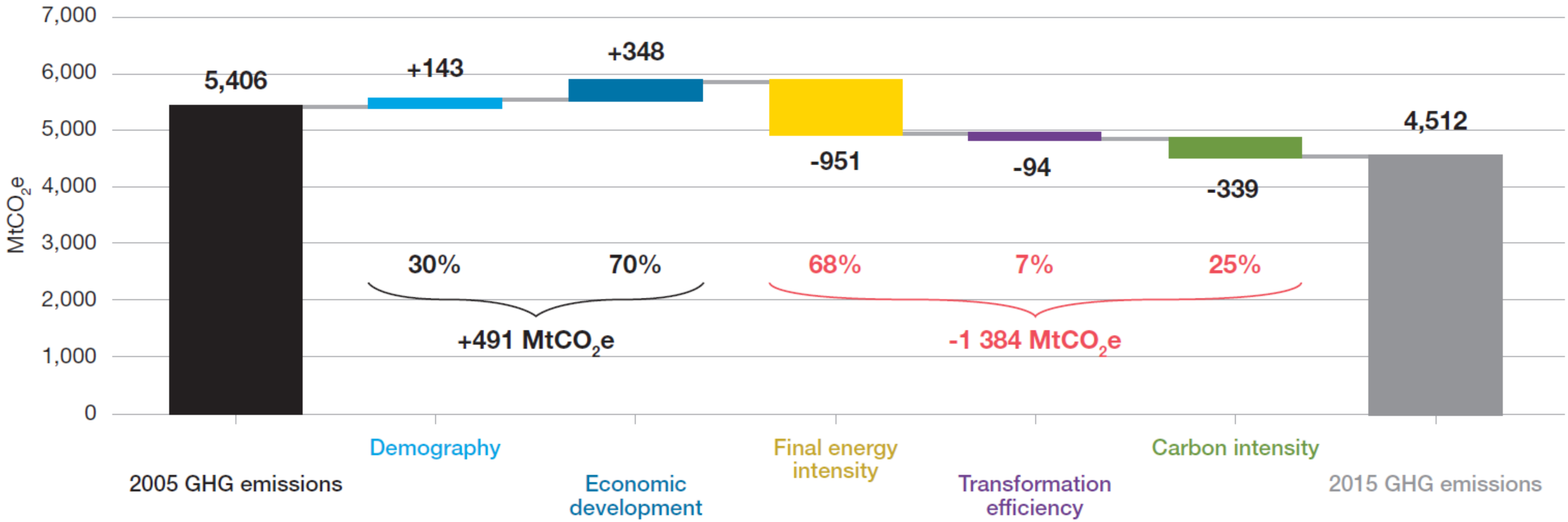
Source : I4CE, 2018

2 | Analysis of interactions in the climate and energy framework

a. Ex-post analysis (2005-2015)

The decoupling of final energy demand and GDP has been the most important driver of GHG emissions reductions

Drivers of GHG emissions variations in the EU (2005-2015)

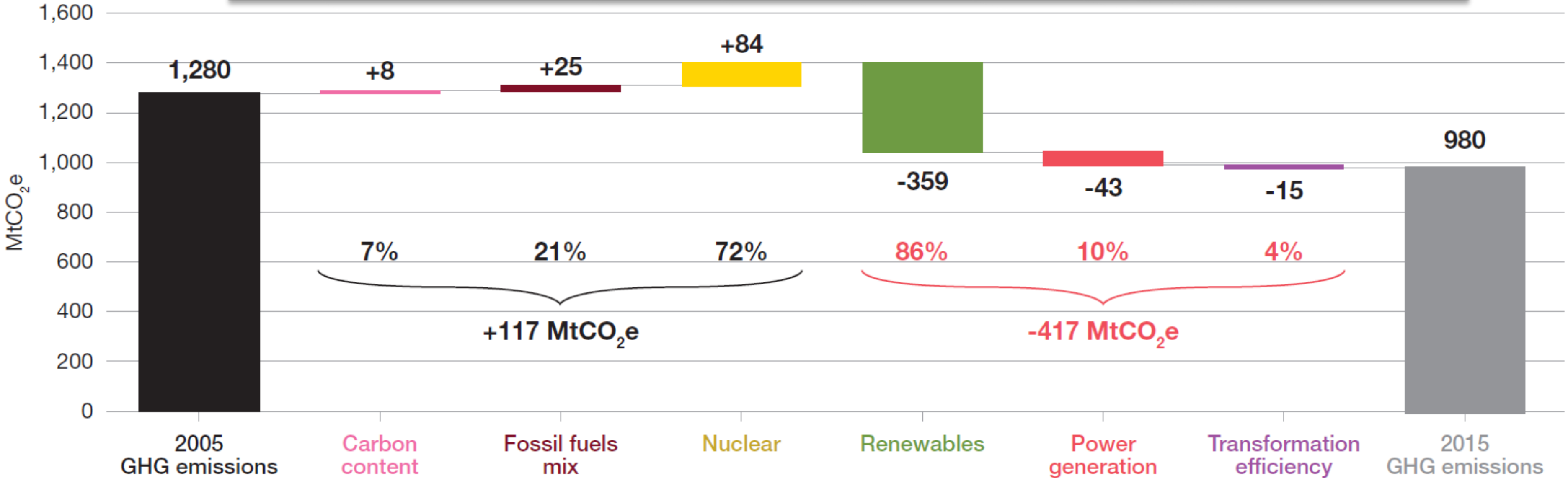


Source : I4CE, 2017

- An **increased efficiency of energy use**, as well as **structural changes in the EU economy** explain the major contribution of final energy intensity to the decrease in GHG emissions over 2005-2015: **-951 $MtCO_2e$** in total.
- The move towards **less carbon intensive fuels** and improvements in the **transformation efficiency of energy** also participated in the decrease in GHG emissions, respectively **-339 and -94 $MtCO_2e$**.
- On the contrary, an increase in population and in GDP/capita contributed to an increase in GHG emissions over 2005 – 2015 : respectively **+143 and 348 $MtCO_2e$**.

GHG emissions reductions in the power sector mainly came from the deployment of renewables

Drivers of GHG emissions variations from the power sector in the EU (2005-2015)

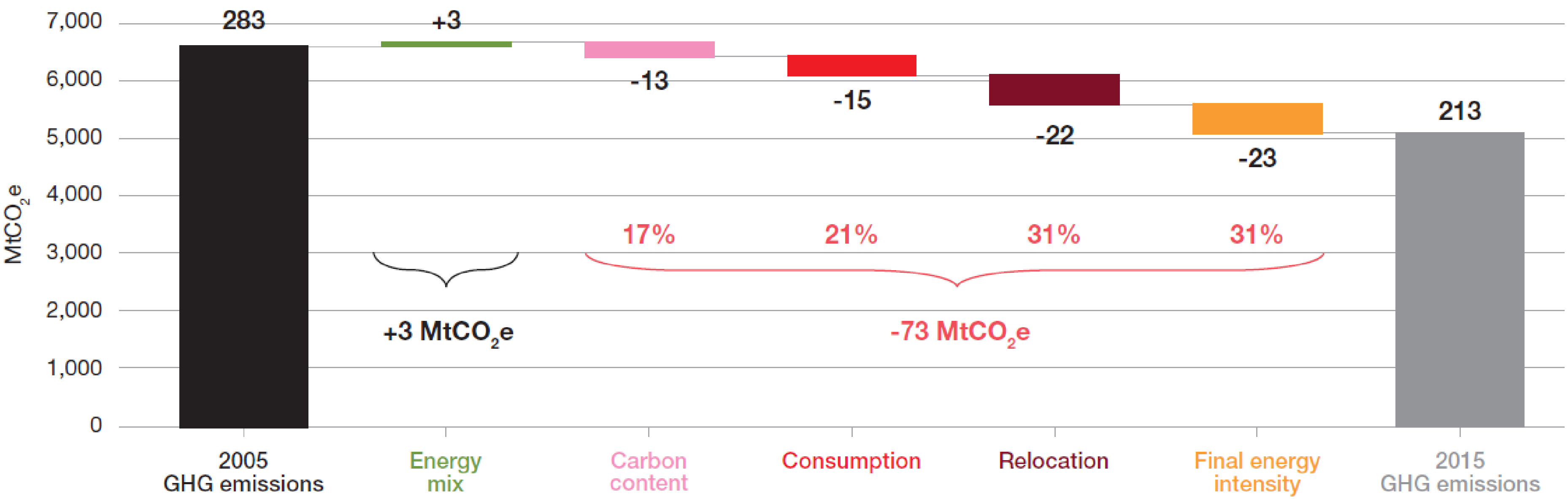


Source : I4CE, 2017

- The **deployment of renewable sources of energy** was the most important driver in decreasing GHG emissions in the power sector over 2005-2015: **-359 $MtCO_2e$** over the period
- The **decrease in power generation** was the second most important contributor to GHG emissions reductions : **-43 $MtCO_2e$**, followed by an improvement in the fuel efficiency of thermal power plants : **-15 $MtCO_2e$**.
- All in all, the evolution of the **relative share of the different fossil fuels** in the fossil fuels mix was a net contributor to GHG emissions : **+25 MtCO2e**
- The decline in the share of nuclear power led to an increase in GHG emissions: **+84 MtCO2e**
- Finally, the evolution of the **carbon content of fossil fuels** slightly contributed to increasing GHG emissions : **+ 8 $MtCO_2e$**

GHG emissions reductions in the iron & steel sector mainly came from energy efficiency and a relocation of production

Drivers of GHG emissions variations from the iron & steel sector in the EU (2005-2015)

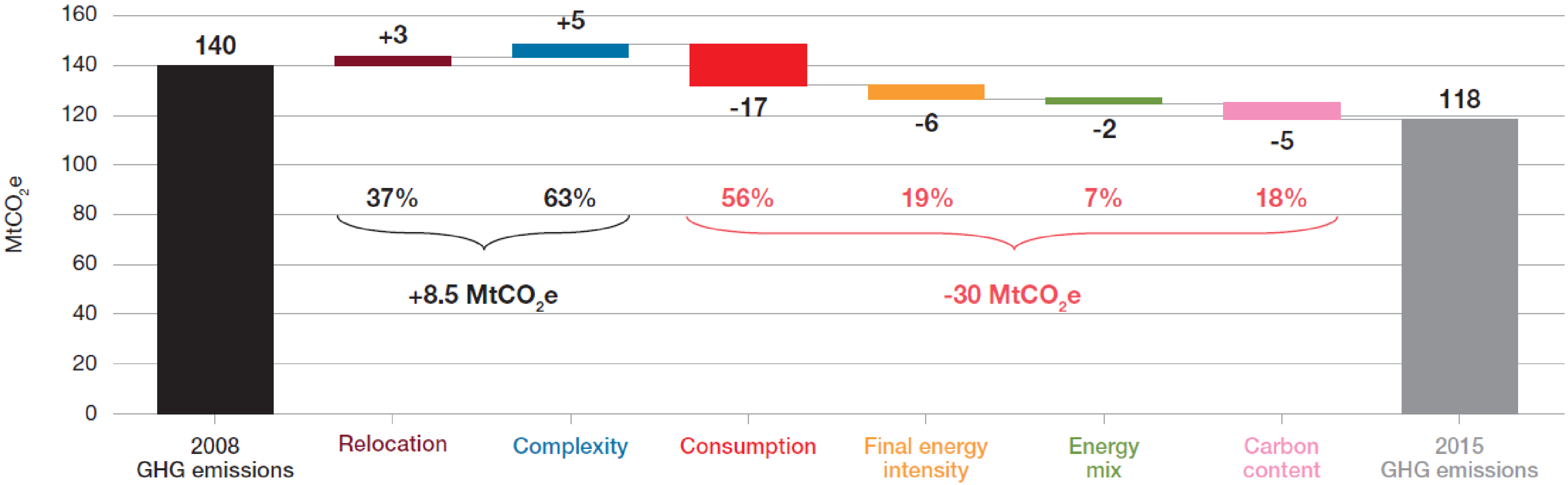


Source : I4CE, 2017

- **Energy efficiency** was the most important driver in decreasing GHG emissions in the iron & steel sector over 2005-2015: **-23 $MtCO_2e$** over the period.
- The **relocation of production outside the EU** was overall the second most important contributor to GHG emissions reductions: **-22 $MtCO_2e$**., followed by the decrease in the demand for iron and steel : **-15 $MtCO_2e$.**
- Finally, the respective carbon content of the fuels used decreased over the period, leading to a decrease in GHG emissions : **-13 $MtCO_2e$**, of which -**10 $MtCO_2e$** are estimated to come from the decarbonisation of electricity.
- The evolution of the share of the different energy sources on the contrary contributed to an increase in GHG emissions over the period : **+3$MtCO_2e$**

The decline in the demand for refined products has been the most important driver of GHG emissions reductions

Drivers of GHG emissions variations in the EU28 refining sector * (2008-2015)



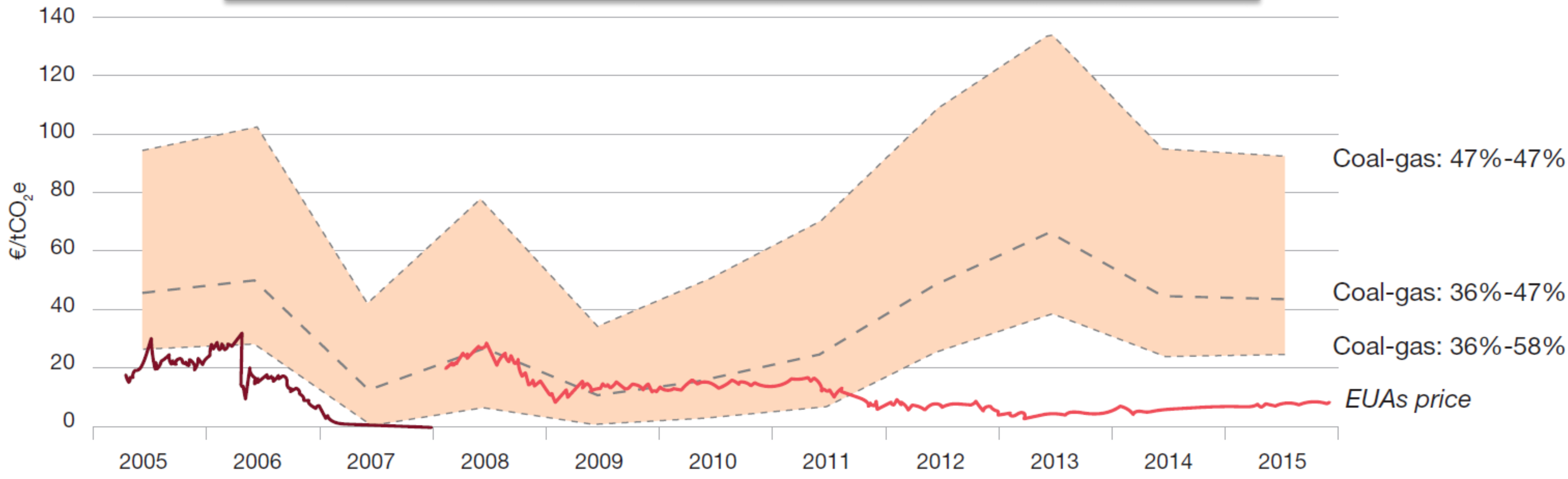
Source : I4CE, 2018

- The **decrease in the demand for refined products** has been the most important driver in decreasing GHG emissions in the refining sector over 2008-2015 : **-17 $MtCO_2e$** over the period .
- **Energy efficiency** has been the second most important contributor to GHG emissions reductions : **- 6 $MtCO_2e$**, followed by a **reduction in the carbon content of the respective fuels used** : **- 5 $MtCO_2e$**, about half of which comes from the decarbonisation of electricity.
- Finally, the **evolution of the share of the different energy sources** has resulted in a decrease in emissions : **- 2 $MtCO_2e$.**
- On the other hand, the **growing complexity of refined products** led to an increase in GHG emissions over the period : **+5 $MtCO_2e$**, as well as a relative **relocation of production in the EU** : **+3 $MtCO_2e$.**

** GHG emissions in the refining sector were calculated from Eurostat data on final energy consumption by source in refineries. Consequently, they do not include GHG emissions coming from fluid catalytic cracking.*

Historically, the EU ETS had a minor impact on GHG emissions reductions - at least in the power sector

Carbon switching price for different coal and gas generation efficiency in the EU28 in comparison with the EU ETS price



Source : I4CE, from BP 2017 (Gas : Heren NBP Index; Coal : IHS Northwest Europe); and from ICE futures Europe (forward dec 2007 for EUAs price phase I and spot price for phases II & III)

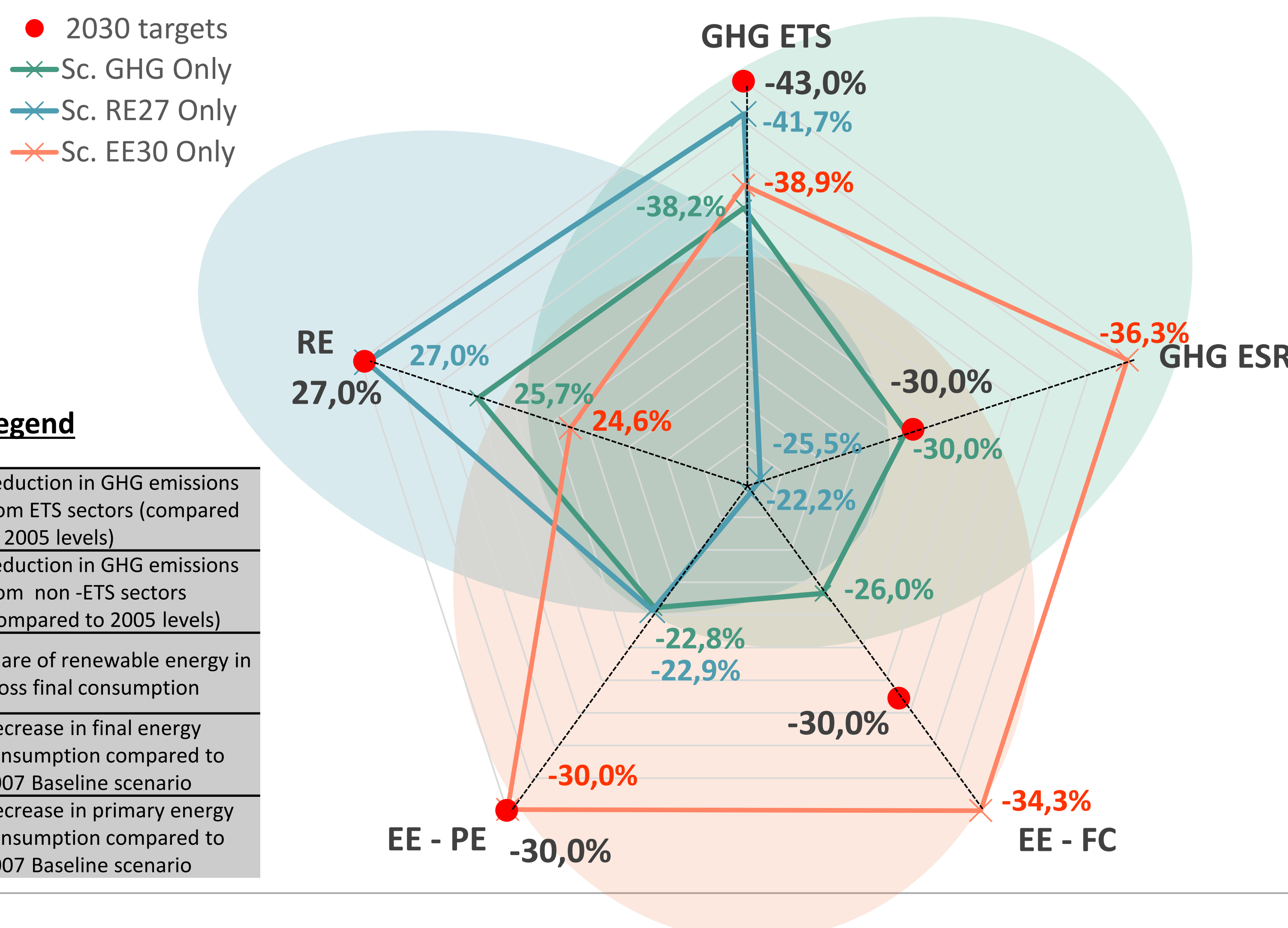
- Given the relative coal and gas prices, and taking into account a large range of possible thermal efficiencies for coal and gas power plants, **the price of EUAs could only trigger a coal-to-gas switch in the 2005-2011 period**.
- GHG emissions coming from the evolution of the fossil fuels mix in this period can be attributed to the carbon price signal induced by the EU ETS: **around 50 $MtCO_2e$**, which were more than offset by additional GHG emissions stemming from a gas-to-coal switch after 2011.

2 | Analysis of interactions in the climate and energy framework

b. Projections to 2030

Understanding policy interactions through modelling: policies contribute to several objectives

Achievement of EU 2030 targets in different scenarios



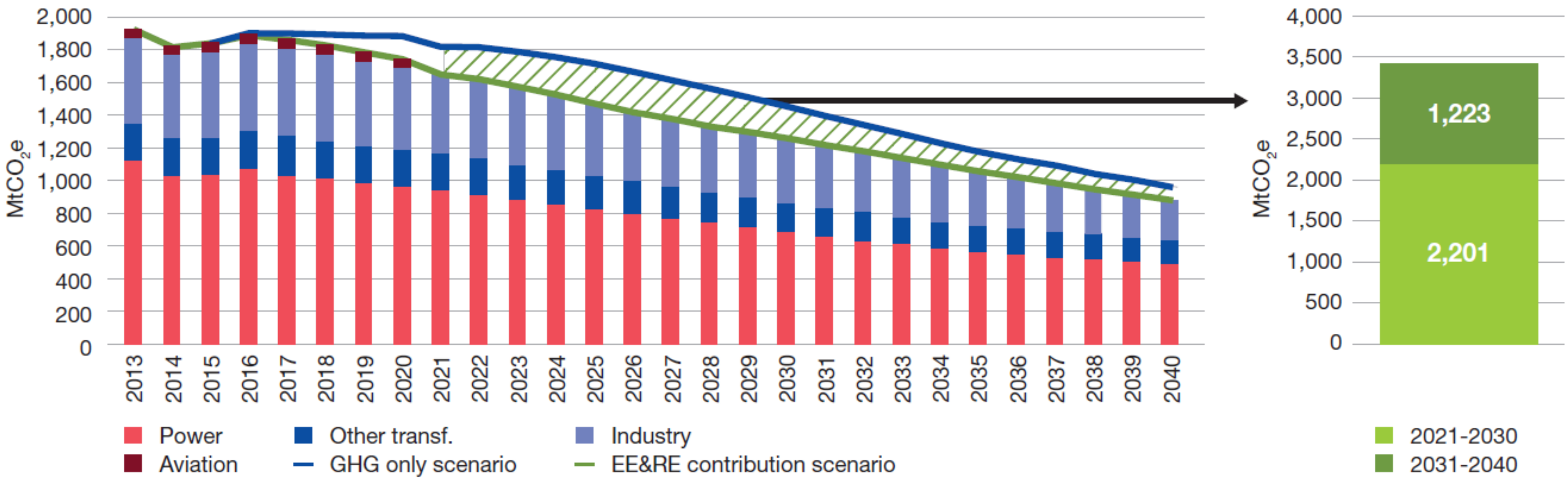
Legend

GHG ETS	Reduction in GHG emissions from ETS sectors (compared to 2005 levels)
GHG ESR	Reduction in GHG emissions from non -ETS sectors (compared to 2005 levels)
RE	Share of renewable energy in gross final consumption
EE - FC	Decrease in final energy consumption compared to 2007 Baseline scenario
EE - PE	Decrease in primary energy consumption compared to 2007 Baseline scenario

Source : Enerdata, 2017

EE and RE policies continue to have a significant impact on GHG emissions covered by the EU ETS and the ESR after 2020

GHG emissions covered by the EU ETS (left) and contribution of energy efficiency and renewable energy policies on GHG emissions reductions in ETS-sectors over 2021-2040 (right)



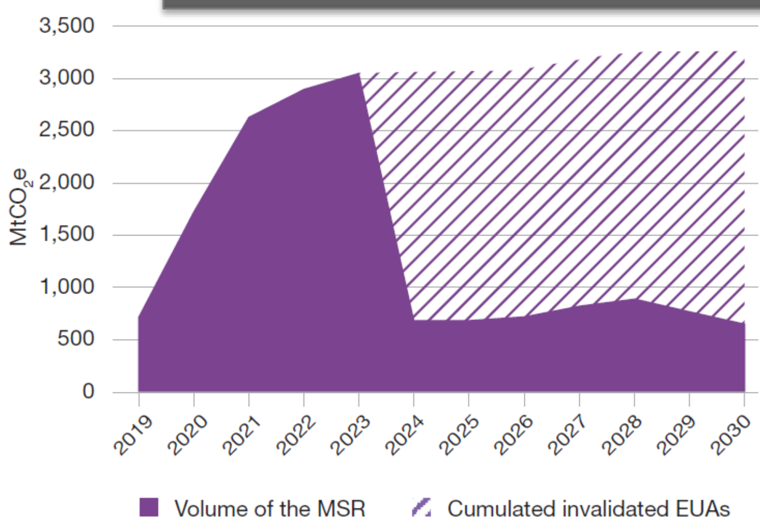
Source : Enerdata, 2017

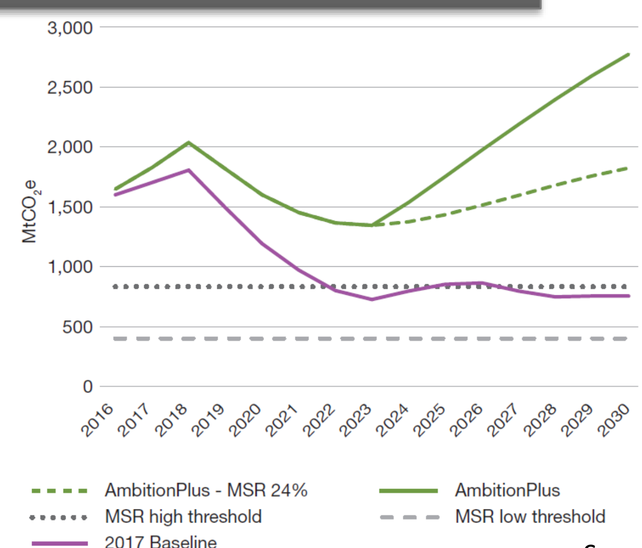
- In total over 2021- 2030, **energy efficiency and renewable energy policies are estimated to contribute to a reduction of 2.2 GtCO$_2$e in GHG emissions covered by the EU ETS** (≈1,5 years of Phase IV allowances, or 95% of reductions required from ETS sectors)
- In total over 2021- 2030, **energy efficiency and renewable energy policies are estimated to contribute to a reduction of 2.1 GtCO$_2$e in GHG emissions covered by the ESR** (≈10% of cumulated AEAs, or 2.5 times the amount of reductions required from non-ETS sectors)

Counterproductive interactions undermine the effectiveness of the EU ETS and the ESR to 2030

- Because of counteractive interactions, the EU ETS is **not expected to drive GHG emissions reductions in the post-2020 period**
  - **GHG emissions reductions notably driven by renewable energy and energy efficiency policies** are expected to be sufficient to respect the EU ETS target in Phase IV
  - → Its **carbon price signal will be depressed** and even the cheapest abatement options may be disregarded.
- The MSR absorbs a **significant number of allowances**, but is **not sufficient to make the EU ETS resilient** to the effect of other policies
- The persistent formation of surplus **undermines the role of the EU ETS and the ESR in guaranteeing the achievement of climate targets**

Volume of the MSR (left) and evolution of the surplus (right)



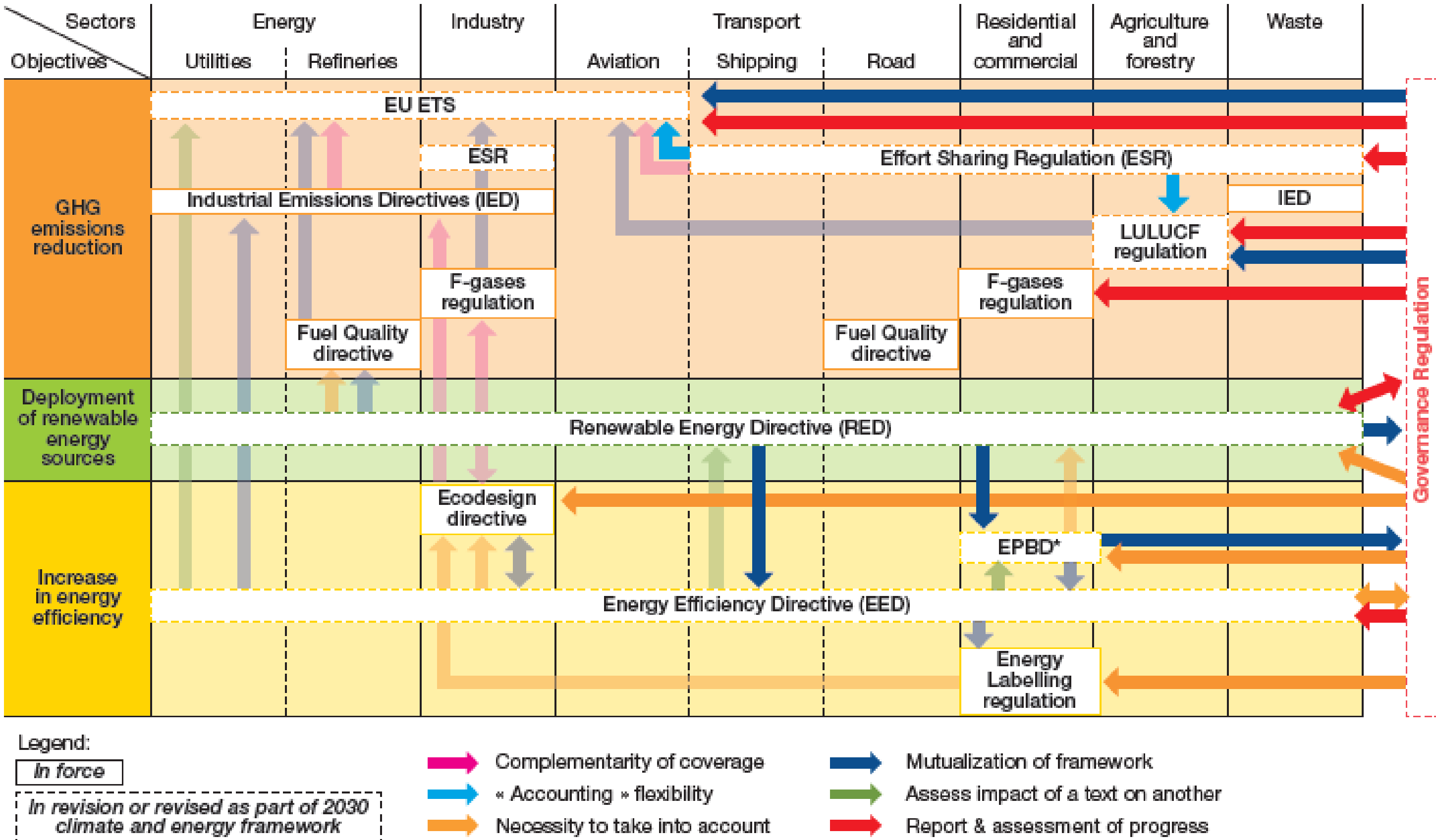


Source : Enerdata, 2017

3 | An enhanced governance approach to implement before 2030 a policy mix compatible with the Paris Agreement

An unavoidable requirement: assessing the impact of policies on others

In the current climate and energy framework, only the energy efficiency directive requires the assessment of its impact on other policies. The proposed regulation on the Governance of the Energy Union is a first step towards a more coherent policy package but it does not include requirements to assess the impact of policies on one another at EU level



* *EPBD: Energy performance of buildings directive.*

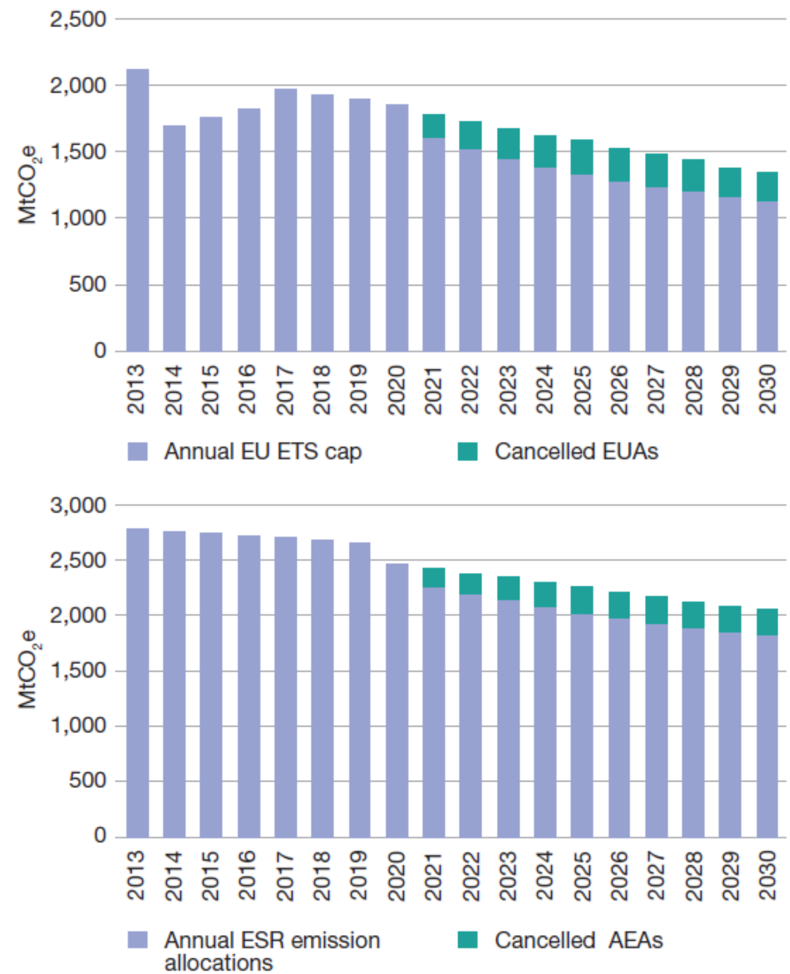
Interpretation of the graph: The arrows represent the interactions between the different legislative texts of the climate and energy framework. The colors represent the nature of the interactions. Nontransparent arrows represent interactions which were introduced with the revision of the 2030 climate and energy framework.

Source : I4CE, 2017

Aligning EU climate and energy policies in the 2030 policy framework enables to mitigate counteractive interactions

- **"Alignment" of the EU ETS and of the ESR to account for GHG emissions reductions coming from other policies** by removing from the EU ETS cap and from ESR AEAs the contribution of other policies to GHG emissions reductions
- The alignment of the EU ETS cap within the EU 2030 energy and climate framework restores its effectiveness :
    - The **surplus of EUAs is very quickly resorbed** and goes below the lower threshold of the MSR from 2023
    - The **EU ETS becomes a driver of abatement**: the carbon price signal leads to a deployment of renewable energy sources sufficient to achieve EU 2030 target and it leads to an immediate switch to less carbon-intensive energy sources
- The alignment of AEAs prevents the formation of surplus on the ESR and incentivizes **additional GHG emissions reductions in sectors covered by the ESR**
- In 2030, resulting GHG emissions are lower than without the "alignment":
    - **- 47% /2005 levels** in ETS sectors
    - **- 37% /2005 levels** in non- ETS sectors

EU ETS cap (top) and ESR annual emissions allocations (bottom) over 2021-2040 in the "Aligned scenario"



EU long-term ambition needs to be increased in line with the objective of the Paris Agreement

EU commitment under the Paris Agreement [2015]
Holding the increase in the global average temperature to **well below 2°C** above pre-industrial levels and pursuing efforts to limit the temperature increase to **1.5°C**

*EU long-term objective was set in 2009, before the Paris Agreement and the goal of maintaining global temperature increase to **well-below** 2°C*

EU's submitted contribution to Paris Agreement

EU translation of long-term temperature goal

Mid-term (2030)

EU NDC [2015]
Binding target of an **at least 40% domestic reduction in GHF emissions by 2030** compared to 1990

Long-term (2050)

EU long-term climate objective [2009]
Objective endorsed by EU leaders, in the context of necessary reductions according to the IPCC by developed countries as a group, to reduce its emissions by **80-95% by 2050 compared to 1990**

Implementation in EU legislation

*EU main policy instruments to achieve GHG emission reduction targets – the EU ETS and the Effort Sharing – define carbon budgets and thus **do not ensure the achievement of EU NDC***

The continuation of trends defined by the 2030 climate and energy framework would not enable to achieve the 2050 objective. Efforts would need to significantly increase after 2030 to reach a reduction in GHG emissions of 80-95%/1990 levels in 2050.

Modelling of a pathway compatible with long-term objective

2030 climate and energy framework [2017-]
EU legislation to implement 2030 targets : in particular the EU ETS and the Effort Sharing Regulation

Definition of 2030 target based on 2050 roadmap modelling

2050 low-carbon economy roadmap [2011]
Roadmap published by the Commission to describe a pathway consistent with a **reduction of 80% in domestic GHG emissions in 2050**

The EU ETS trajectory – defined by the annual reduction of its cap – corresponds in 2050 to an 85% reduction compared to 2005 levels in GHG emissions covered by the EU ETS, while the 2050 roadmap projects a reduction of 90% in 2050 compared to 2005 in GHG emissions in ETS-sectors

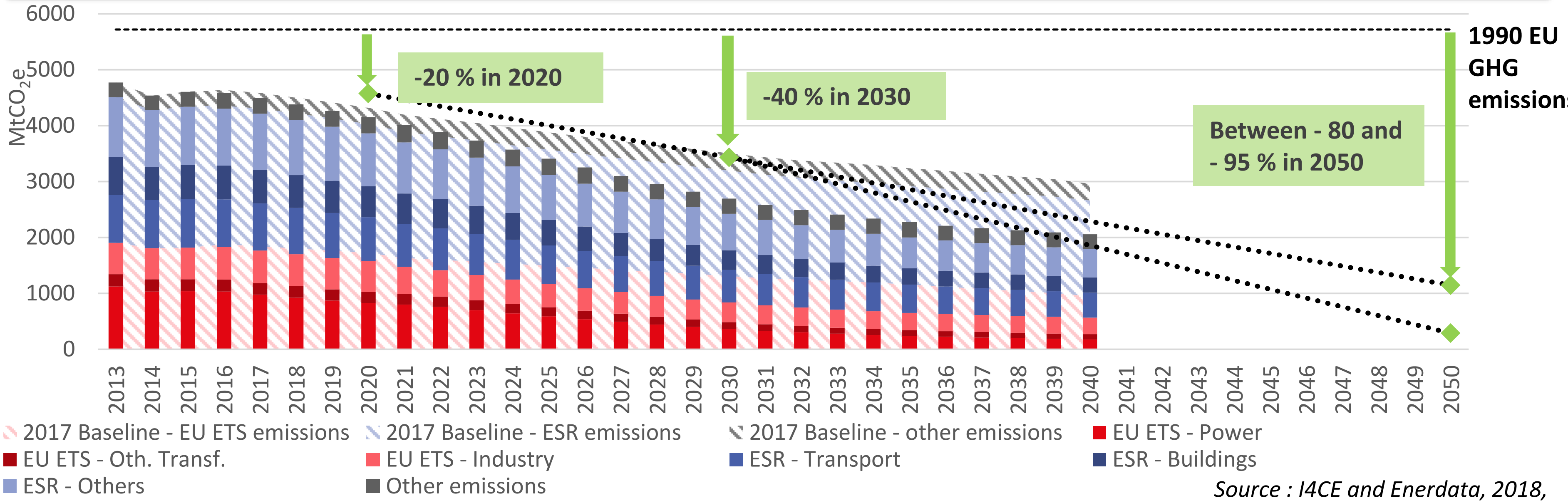
- **EU international commitment**
- **EU legislation**
- **EU objective (endorsed by Council but not implemented in legislation)**
- **EU Commission's publication (no legal value)**

- **Link between the different elements**
- **Misalignment**

Source : I4CE, 2018

GHG emissions trends defined by the 2030 climate and energy framework as currently negotiated fall short of the EU 2050 objective

GHG emissions paralleled with EU climate targets pathway (in the "2017 Baseline" and the "AmbitionPlus" scenarios)



Source : I4CE and Enerdata, 2018, with data from the EEA

- To have a sustainable decarbonisation pathway, an **anticipation of the suitable transformation of the energy system** to achieve drastic GHG emissions reductions in the long-term is required, as well as a **timely deployment of low-carbon solutions**
- An update of the 2050 roadmap consistently with the EU carbon budget and the "net-zero" emissions target would **inform the adequate adaptation of climate and energy policies, at the EU-level and at the national level**.
  - At the EU level, the roadmap would enable setting **appropriate long-term targets for the EU ETS and the ESR**, as well as **intermediate 2040 targets** + could also be used to elaborate a **corridor of trajectories for the social value of carbon**
  - At the national level, **INECPs and long-term low-emission strategies** should also build on the updated 2050 roadmap

Conclusion

- The deployment of **renewable energy sources** and an **increased energy efficiency** contributed greatly to reducing GHG emissions over 2005-2015.
- Renewable energy and energy efficiency policies continue to be the main drivers of GHG emissions reductions up to 2030, under the assumptions that specific policies are implemented to achieve 2030 targets.
- These emissions reductions, as they are not appropriately taken into account, create **counteractive interactions within the 2030 climate and energy framework**, which undermines its effectiveness and jeopardizes the achievement of climate targets.
- The legislative texts as currently negotiated lack adequate provisions to mitigate **counterproductive interactions.**
- Furthermore, they **fall short of the EU long-term ambition**, which is itself insufficient to respect its commitment under the Paris Agreement.
- A **two-fold alignment of the policy package is thus required**: within the 2030 climate and energy framework to mitigate counteractive policy interactions and with an increased long-term ambition.

10 policy recommendations are defined, to make the EU climate and energy policy framework consistent with the Paris Agreement before 2030, by:

1. **Setting the EU long-term climate targets right**, taking into account the goals of the Paris Agreement;
2. Defining a climate and energy policy framework **aligned with long-term targets at the EU and national levels**;
3. Ensuring the **coherency of the policy framework** and mitigating counteractive interactions.

10 policy recommendations

To make the EU climate and energy policy framework consistent with the Paris Agreement before 2030 (1/2)

STEP 1 : Setting the EU long-term climate targets right

1. Evaluating the **EU carbon budget** in relation to the 2018 IPCC 1.5°C report, based on the principles of capability, equality and responsibility
2. Translating this carbon budget as well as the "net-zero" emissions target in an **updated 2050 EU roadmap**, jointly elaborated with representatives from all sectors through an openly carried out prospective exercise
3. Setting **appropriate and realistic 2050 targets** for sectors covered by the EU ETS and the ESR with **intermediate 2040 targets**

STEP 2 : Defining a climate and energy policy framework aligned with long-term climate targets

- At the EU level :

4. **Calibrating EU policy instruments** (in particular the EU ETS and the ESR) according to the updated 2050 roadmap as soon as possible before 2030, using all possible windows offered by the Governance timeline and other review processes (i.e. for the EU ETS, building on the intended reviews in the light of the implementation of the Paris Agreement to appropriately increase the linear reduction factor of the cap)
5. Calculating a **corridor of social values of carbon in the EU** until 2050, aligned with long-term climate ambition, which economic stakeholders could use as a reference and on which could lean public policies
6. Assessing regularly EU progress towards meeting its targets and introducing provisions to allow a **periodic ratcheting up of ambition** in line with the stocktakes of the Paris Agreement

10 policy recommendations

To make the EU climate and energy policy framework consistent with the Paris Agreement before 2030 (2/2)

STEP 2 : Defining a climate and energy policy framework aligned with long-term climate targets

- At the national level :

4. Calling for an **alignment of Member States' long term low-carbon strategies** to the 2050 low-carbon roadmap
5. Making sure Member States' **10-year integrated national climate and energy plans (INECPs) are aligned to their long-term low-carbon strategy and to the 2050 EU roadmap**

STEP 3 : Ensuring the coherency of the different pieces of the climate and energy policy framework

9. Carrying out **an ex-ante assessment** of the interactions between energy and climate policies – at the **national and EU levels**, as well as **annual ex-post assessments**
10. **Introducing provisions to adapt policies accordingly** as soon as possible – directly at EU level and through recommendations by the EU Commission for an adaptation of policies in the INECPs

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Thank you for your attention!

Do not hesitate to download our policy brief and the full report:

"Mind the gap:
Aligning the 2030 EU climate and energy policy framework to meet long-term climate goals "

The contribution of five drivers to the variations in GHG emissions is quantified

$$GHG\ emissions = Population \times \frac{GDP}{Population} \times \frac{Final\ energy\ consumption}{GDP} \times \frac{Gross\ inland\ consumption}{Final\ energy\ consumption} \times \frac{GHG\ emissions}{Gross\ inland\ consumption}$$

↓ **LMDI**

$$\Delta GHG\ emissions = Demography\ effect + Economic\ development\ effect + Energy\ intensity\ effect + Transformation\ efficiency\ effect + Carbon\ intensity\ effect$$

Effects	Variables	Description
Demography	$Population$	Effect of the evolution of the population
Economic development	$\frac{GDP}{population}$	Effect of the evolution of the GDP/capita
Final energy intensity	$\frac{Final\ energy\ consumption}{GDP}$	Effect of the evolution of the amount of final energy used per unit of GDP
Transformation efficiency	$\frac{Gross\ inland\ consumption}{Final\ energy\ consumption}$	Effect of the evolution of the fuels conversion efficiency
Carbon intensity	$\frac{GHG\ emissions}{Gross\ inland\ consumption}$	Effect of the evolution of the carbon intensity of the primary energy mix

The contribution of six drivers to the variations in GHG emissions in the power sector is quantified

$$GHG\ emissions = Total\ power\ generation \times \frac{Power\ generation\ from\ fossil\ fuels}{Total\ power\ generation} \times \sum_i \frac{Power\ generation\ from\ source\ i}{Power\ generation\ from\ fossil\ fuels} \times \frac{Fuel\ input\ of\ source\ i}{Power\ generation\ from\ source\ i} \times \frac{GHG\ emissions\ from\ source\ i}{Fuel\ input\ of\ source\ i}$$

$$i = coal, oil, gas$$

LMDI

$$\Delta GHG\ emissions = Power\ generation\ effect + Renewables\ effect + Nuclear\ effect + Fossil\ fuels\ mix\ effect + Transformation\ efficiency\ effect + Carbon\ content\ effect$$

Effects	Variables	Description
Power generation	$Total\ power\ generation$	Effect of the evolution of the amount of electricity and heat production
Renewables	$\frac{Power\ generation\ from\ fossil\ fuels}{Total\ power\ generation}$	Effect of the evolution of the share of renewable sources in the power mix
Nuclear		Effect of the evolution of the share of nuclear in the power mix
Fossil fuels mix	$\frac{Power\ generation\ from\ source\ i}{Power\ generation\ from\ fossil\ fuels}$	Effect of the evolution of the share of the different fossils fuels
Transformation efficiency	$\frac{Fuel\ input\ of\ source\ i}{Power\ generation\ from\ source\ i}$	Effect of the evolution of the fuel efficiency of thermal power plants
Carbon content	$\frac{GHG\ emissions\ from\ source\ i}{Fuel\ input\ of\ source\ i}$	Effect of the evolution of the fossil fuels' carbon content

The contribution of six drivers to the variations in GHG emissions in the refining sector is quantified

$$GHG\ emissions = Final\ demand\ for\ refined\ products \times \frac{Production\ of\ refined\ products}{Final\ demand\ for\ refined\ products} \times \frac{Activity\ levels}{Production\ of\ refined\ products}$$
$$\times \frac{Final\ energy\ consumption}{Activity\ levels} \times \sum_{w} \frac{Final\ energy\ consumption\ of\ source\ w}{Final\ energy\ consumption} \times \frac{GHG\ emissions\ from\ source\ w}{Final\ energy\ consumption\ of\ source\ w}$$

LMDI

$$w = coal, oil, gas, biomass\ \&\ biofuels, electricity$$

$$\Delta GHG\ emissions = Demand\ effect + Relocation\ effect + Complexity\ effect + Final\ energy\ intensity\ effect + Energy\ mix\ effect + Carbon\ content\ effect$$

Effects	Variables	Description
Demand	$Final\ demand\ for\ refined\ products$	Effect of the evolution of the demand fore refined products
Relocation	$\frac{Production\ of\ refined\ products}{Final\ demand\ for\ refined\ products}$	Effect of the evolution of the relocation of refining activities outside or inside the EU
Complexity	$\frac{Activity\ levels}{Production\ of\ refined\ products}$	Effect of the evolution of the complexity of refined products
Final energy intensity	$\frac{Final\ energy\ consumption}{Activity\ levels}$	Effect of the evolution of the amount of final energy used for a given activity level
Energy mix	$\frac{Final\ energy\ consumption\ of\ source\ w}{Final\ energy\ consumption}$	Effect of the evolution of the energy mix
Carbon content	$\frac{GHG\ emissions\ from\ source\ w}{Final\ energy\ consumption\ of\ source\ w}$	Effect of the evolution of the fuels' carbon content

The contribution of five drivers to the variations in GHG emissions in the iron and steel sector is quantified

$$GHG\ emissions = Apparent\ steel\ use \times \frac{Production\ of\ crude\ steel}{Apparent\ steel\ use} \times \frac{Final\ energy\ consumption}{Production\ index} \times \sum_{w} \frac{Final\ energy\ consumption\ of\ source\ w}{Final\ energy\ consumption} \times \frac{GHG\ emissions\ from\ source\ w}{Final\ energy\ consumption\ of\ source\ w}$$

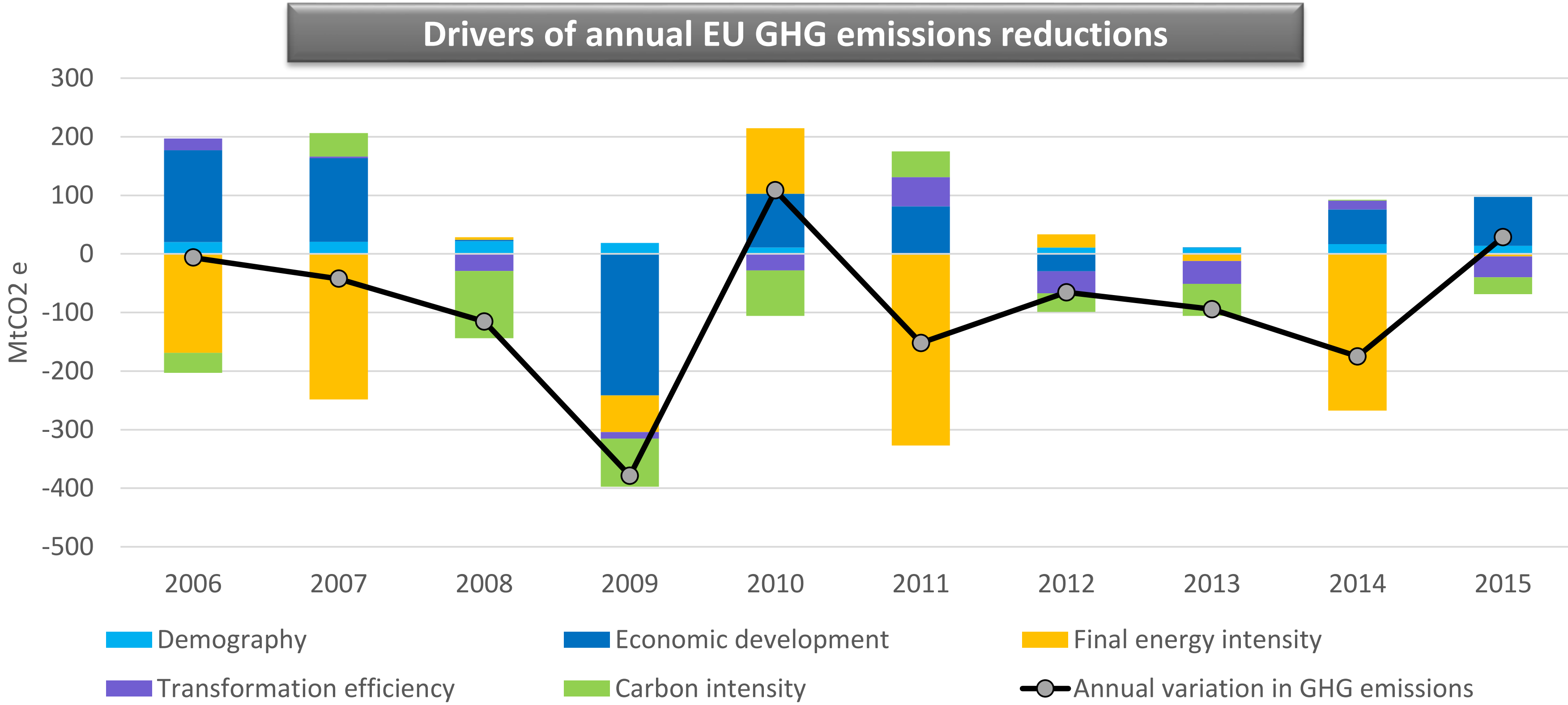
$$w = coal, oil, gas, biomass\ \&\ biofuels, electricity$$

LMDI

$$\Delta GHG\ emissions = Demand\ effect + Relocation\ effect + Final\ energy\ intensity\ effect + Energy\ mix\ effect + Carbon\ content\ effect$$

Effects	Variables	Description
Demand	$Apparent\ steel\ use$	Effect of the evolution of the demand for iron and steel
Relocation	$\frac{Production\ of\ crude\ steel}{Apparent\ steel\ use}$	Effect of the evolution of the relocation of iron and steel production outside or inside the EU
Final energy intensity	$\frac{Final\ energy\ consumption}{Production\ of\ crude\ steel}$	Effect of the evolution of the amount of final energy used for a given production volume
Energy mix	$\frac{Final\ energy\ consumption\ of\ source\ w}{Final\ energy\ consumption}$	Effect of the evolution of the energy mix
Carbon content	$\frac{GHG\ emissions\ from\ source\ w}{Final\ energy\ consumption\ of\ source\ w}$	Effect of the evolution of the fuels' carbon content

Significant annual variations are identified in the contribution of the different drivers to GHG emissions reductions



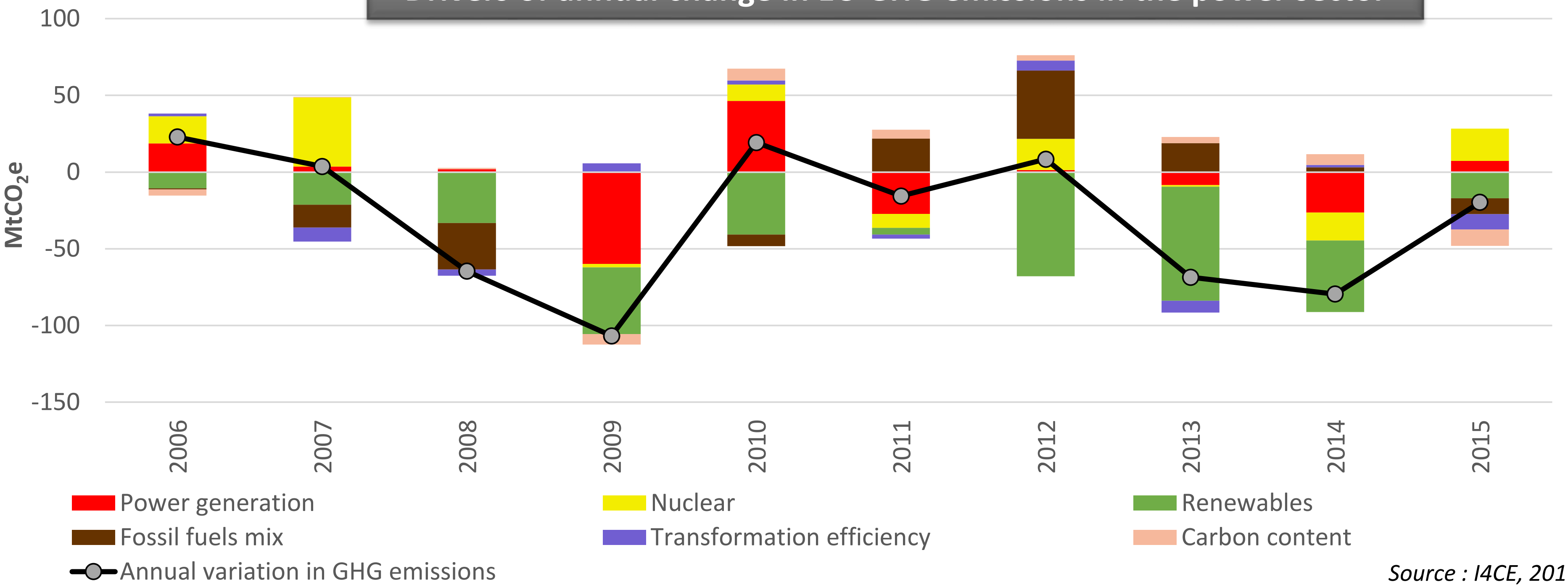
Source : I4CE, 2017

Decomposition analysis' results

- The **increase in population** has steadily contributed to an increase in GHG emissions, as well as the **increase in GDP/capita**, except in 2009 and to a lesser extent in 2012.
- The **final energy intensity** improved almost every year, as well as the **carbon intensity** of the EU energy mix.

Analysis of annual drivers : the deployment of renewables steadily contributed to GHG emissions reductions

Drivers of annual change in EU GHG emissions in the power sector



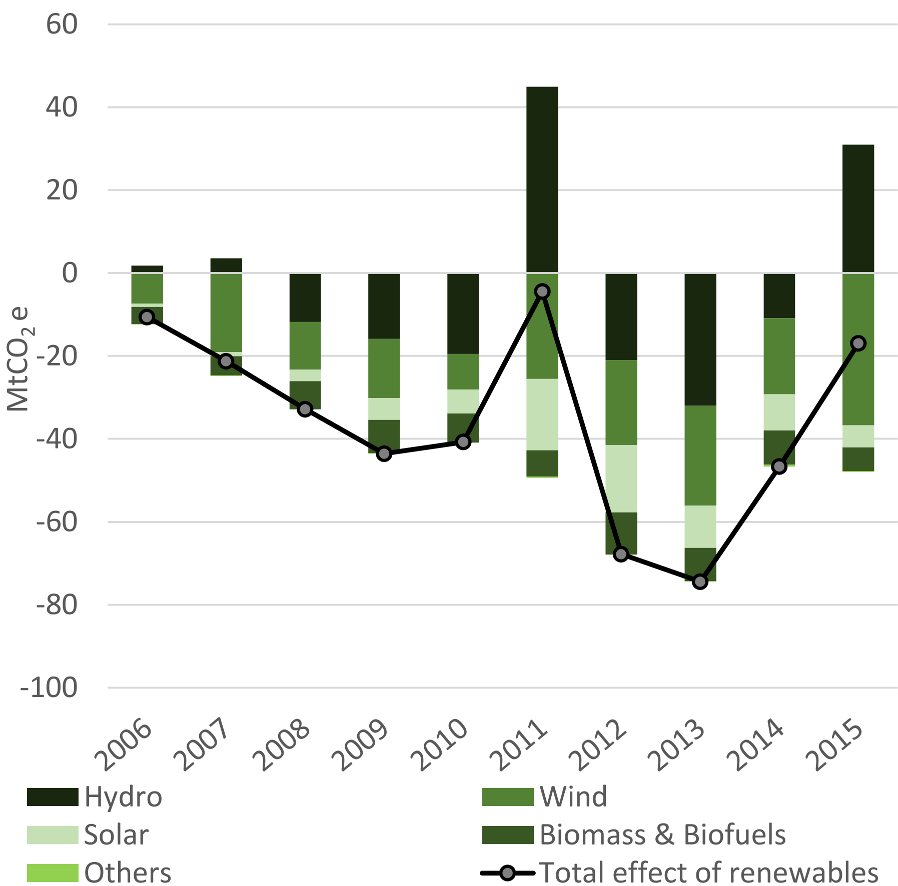
Source : I4CE, 2017

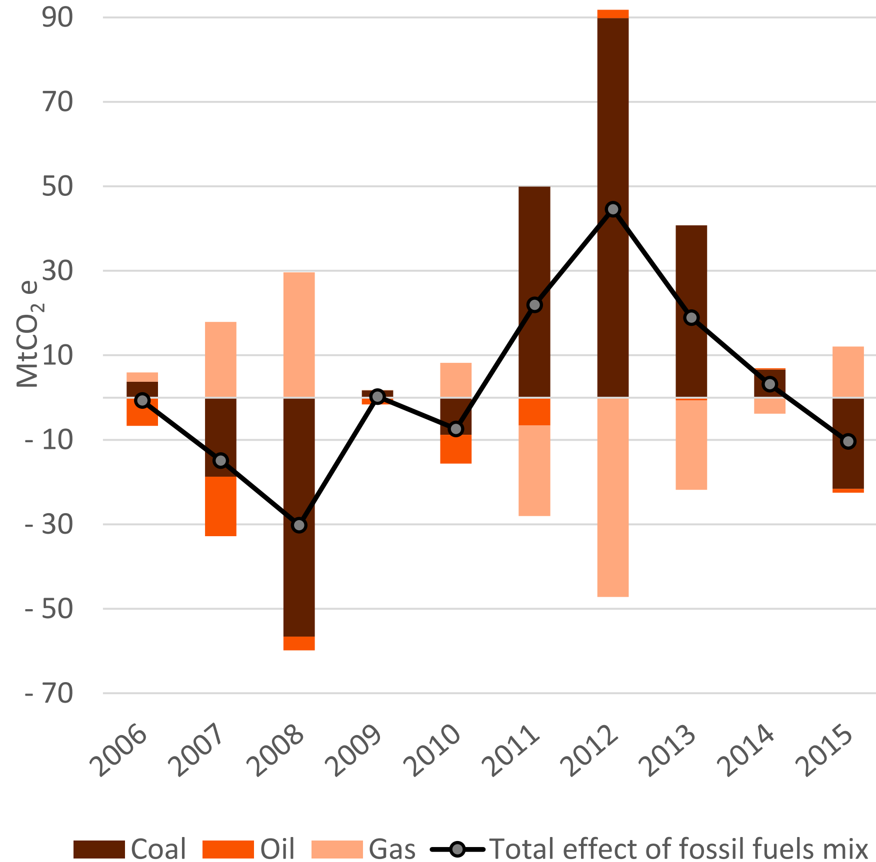
Decomposition analysis' results

- **The deployment of renewables** steadily contributed to the decline of GHG emissions.
- From **2005 to 2010**, the fossil fuel mix tended to be **less carbon-intensive**, while **from 2011 to 2014**, it became **more carbon-intensive** every year.
- The **decrease in power generation in 2009** and the **recovery the subsequent year** had a significant impact on GHG emissions from the power sector (respectively **-60 MtCO2e** and **+46 MtCO2e**).

The decarbonisation of the power sector mainly came from the deployment of renewable sources of energy

Annual contribution of renewables (left) and of the evolution of the fossil fuels power mix (right) to GHG emissions reductions in the power sector by source (2005-2015)





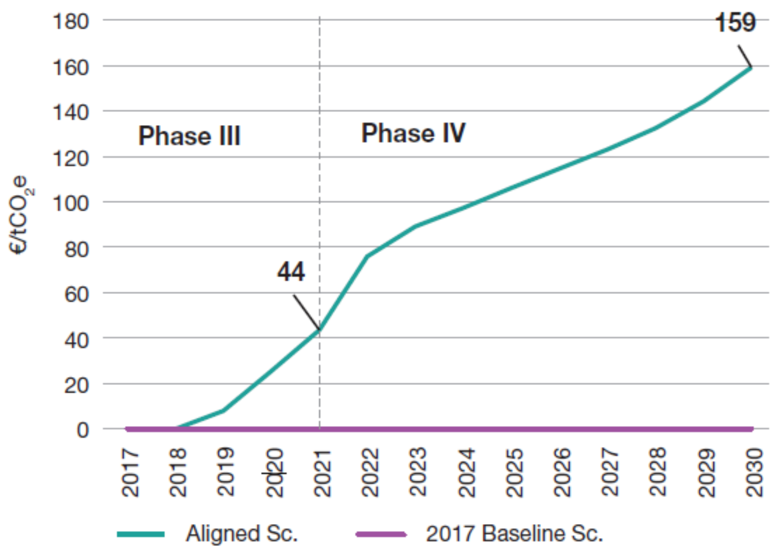
Source : I4CE, 2017

DESIGNING AN AMBITIOUS AND COHERENT POLICY MIX

Aligning EU climate and energy policies in the 2030 policy framework enables to mitigate counteractive interactions

EU ETS carbon value in the Aligned scenario

In the Aligned scenario, the carbon value increases from 2018 to reach 44€/tCO_2e at the beginning of Phase IV



Estimating the cost of GHG reductions required: the carbon value
The carbon value in POLES is **<u>not</u>** the EU ETS market price. It represents the cost of GHG emissions reductions required to respect the constraint set by the EU ETS considering a sliding 5-years carbon budget.

Source : Enerdata, 2017

EU ETS (top) and ESR (bottom) emissions by sector in the Aligned scenario