CHAPTER 1

THE EU ETS EMISSIONS REDUCTION TARGET AND INTERACTIONS WITH ENERGY AND CLIMATE POLICIES

Authors: Matthieu JALARD, Lara DAHAN and Emilie ALBEROLA (I4CE – Institute for Climate Economics), Sylvain CAIL and Kimon KERAMIDAS (ENERDATA)[1]

KEY MESSAGES

- ***Introduction to the proposal for a revised EU ETS directive based on the European Council agreement*** - The -43% of CO_2 emissions reduction EU ETS target and the linear reduction factor reduced at 2.2% from 2021 onwards correspond to a net additional reduction of 556 $MtCO_2e$ of the cumulative emissions cap by 2030. In addition, the European Council enforced in a binding EU target of at least 40% GHG reduction compared to 1990, a binding EU target of at least 27% Renewable Energy Sources (RES) in final energy, and an indicative EU target of at least 27% energy efficiency improvement compared to 2007 baseline - both without any binding targets for individual Member States.

- ***In the EU 2020 energy & climate package, renewable energy policies account for a large share of emissions reductions but do not contributed significantly to the increasing surplus, in contrast to the impact of energy efficiency policies and offsets which were not factored into the cap*** - The surplus undermined the EUA price incentive which seems to have played a weak role, giving however a strong incentive for the 1.2 billion tons of CO_2 emission reductions outside the EU ETS through Kyoto credits (CDM-JI). Steering technology developments in storage and demand response, together with more market based renewable supports and a targeted power market design are likely to enhance the ability of the EU ETS to drive emissions cost effectively in the power sector.

- ***Updated effort sharing among ETS sectors with the revised ETS target*** - According to POLES-Enerdata modeling results, the power sector would be responsible for 73% of total CO_2 emission reductions achieved in the ETS between 2013 and 2030 (556 $MtCO_2e$). This corresponds to a 411 $MtCO_2e$ reduction and a 35% decrease over the period considered. Among other sectors, the industry and the upstream and refining sector would also contribute to an additional 150 $MtCO_2e$ in emission reduction.

- ***Impacts of the new target on EUA prices*** - The CO_2 price path necessary to achieve 2030 EU ETS targets could reach around $€_{2010}$71/tCO_2 in 2030. In non-ETS sectors, like road transport sector, a carbon value of $€_{2010}$274/tCO_2 is necessary to incentivise sufficient reductions that could achieve a 40% reduction in emissions relative to 1990 levels.

- ***EU ETS Interaction with other energy policies*** - The unique GHG emissions reduction target is sufficient to achieve a 27% share of RES in gross final consumption. Attaining the target for energy efficiency would require the implementation of costly energy saving measures. As a consequence, ETS sectors are less constrained and increase their emissions per unit of output compared to the GHG only scenario to reach the overall -40% emissions objective. Therefore the ETS carbon price is reduced significantly around $€_{2010}$10/tCO_2 in 2030.

1. This chapter on the EU ETS emissions reduction target and its interaction with energy policies is based on analysis developed in the COPEC research program workshop organized on September 26th 2014 and results from academic research.

This chapter introduces, in section 1, a synthesis of the European Commission's proposal on the 2030 Framework for climate and energy policies. Section 2 provides an analysis on the extent energy policies that support Renewable Energy Sources (RES) and Energy Efficiency (EE) targets, complementary to the Greenhouse Gas Emissions (GHG) target have impacted the European Union Emissions Trading Scheme (EU ETS) and the consequences in terms of dealing with the European allowances (EUA) surplus until 2030. Then, using POLES modeling results, section 3 presents two scenarios for the EU ETS and their potential impact on EUA prices, on additional investment costs and the effort sharing between EU ETS sectors leading to 2030. Lastly, section 4 provides an overview of how three other emissions trading schemes in the world manage their GHG emission reduction target.

1. SUMMARY OF THE EUROPEAN COMMISSION'S PROPOSAL FOR 2030

The 2020 energy and climate package has been effective in achieving targets but its cost-effectiveness can be put to question

Over the past twenty years, European energy and climate policies have progressively converged in a uniform framework. European Union (EU) energy policies, which have been defined as a balance between three pillars, security of supply, competitiveness, and environmental protection, have first endeavored to create the basis for internal electricity and gas markets, as stated in the Directives 1996/92/EC and 2003/54/EC. The Third Energy Package adopted in 2009, was a way forward to continued liberalization and the integration of energy markets planned for 2014. However, since the mid-2000, policy focus has shifted to climate and environmental objectives. The EU has committed to reduce its GHG emissions by 8% from 2008 to 2012, compared to 1990, through the signature and the ratification of the Kyoto Protocol. As a result, the EU implemented the Emission Trading Scheme (ETS) through Directive 2003/87/EC, which aims to cap emissions from industrial facilities and power plants and allows covered entities to trade emission allowances. For sectors not covered by the EU ETS, where non-price barriers to emissions reductions prevail, Member States were allocated emission reduction targets.

For the first time, in 2007, the European Council approved an "integrated climate and energy policy," which enforced the so called "2020 climate-energy package", and set out the "20-20-20" targets which aim to: (i) reduce GHG emissions by 20% by 2020 compared to 1990; (ii) save 20% of EU energy consumption by 2020 compared to a baseline (2007 PRIMES Reference scenario projection); and (iii) achieve a 20% share of renewables in EU final energy consumption. The distinction between ETS and non-ETS sectors was maintained. Directive 2009/29/EU extended the EU ETS until 2020, and the Effort Sharing Decision distributed efforts mitigation between Member States. For non-ETS sectors this was done according to per capita income. according to their per capita income for non-ETS sectors. Directive 2009/28/EC enforced binding renewable energy targets for each Member State according to their starting point, their potential, and their economic circumstances.

There is no doubt that the 2020 framework has been effective: the EU is on its way to achieve a 24% CO_2 emission reduction by 2020, a 21% share of RES, and a 19% improvement in energy efficiency.[2] However, as developed in section 2, concerns have been raised stating that the cost-effectiveness of the proposed framework could be improved and that tradeoffs between targets and objectives were not been sufficiently identified and addressed. Interactions between various economic instruments have in some ways undermined the ability of the EU ETS to drive emissions reductions efficiently. The fragmentation of policies to promote renewable generation, and the promotion of non-market based supports has led to costly deployment of renewables and undermined the functioning of power markets (Roques, 2014). Evidence is also mounting that the design of the power market implemented since the 1996 Directive is not consistent with promoting low carbon technologies and can conflict with security of supply (OECD 2015, IEA 2014).

The 2030 energy and climate package: towards a stronger focus on cost-effectiveness and security of supply in the energy union framework

In 2013, the European Commission initiated a policy dialogue through a Green Paper on the framework for climate and energy policies.[3] The objective

2. European Commission, (EC) *EU Energy, Transport and GHG Emissions Trends to 2050*. 2013.
3. EC, *A framework for 2030 energy and climate policies*, Green Paper, 2013.

was to draw lessons from the 2020 framework and analyze how tradeoffs and conflicts could be managed more effectively. Discussions focused on whether a GHG emission reduction target alone would be preferable, or whether multiple targets should be pursued using various instruments. Other issues discussed were the value and nature of the targets whether they should be binding or solely indicative, and how efforts should be allocated among Member States.

Leading on from these discussions, the European Commission published the Communication "*A policy framework for climate and energy and energy in the period from 2020 to 2030*" in 2014.[4] The proposal put forward three objectives, that follow up on the 20-20-20 strategy and by 23rd October 2014, the European Council agreed on the following 2030 EU climate and energy targets:[5]

- A binding EU target of at least 40% GHG reduction compared to 1990;
- A binding EU target of at least 27% RES in final energy, and no binding targets per Member States were set out;
- An indicative EU target of at least 27% energy efficiency improvement compared to 2007 baseline (PRIMES Reference scenario projection) - without any binding targets for individual Member States.

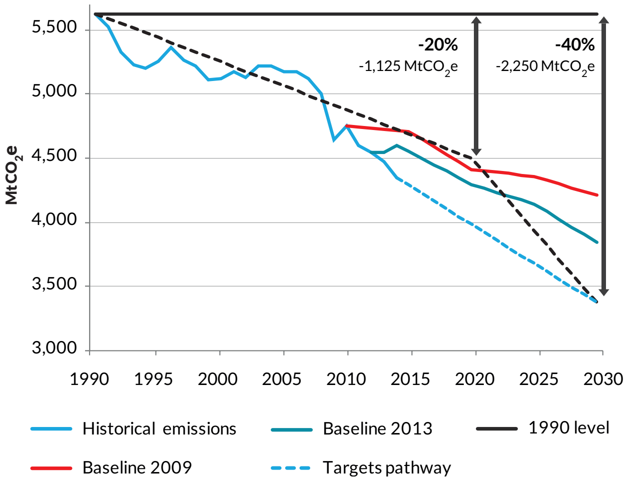
As far as economic instruments, a well-functioning and reformed EU ETS was confirmed to be the primary instrument to achieve the EU emission reduction target in a cost-effective manner. Effort sharing between Member States will be allocated in 2016, with guidelines stipulating that all Member States should participate in the effort, balancing considerations of fairness and solidarity. A new governance framework was also proposed, based on national plans for competitive, secure and sustainable energy as well as a set of key indicators to assess progress over time. The European Council agreed that a reliable and transparent governance system will be developed to help ensure that the EU meets its energy policy goals.

The 2030 framework marks an inflection point in energy and climate priorities in the ever-changing international context, featured by a widening energy cost differential between international competitors and a slow and uncertain economic recovery. International climate change talks and global cooperation are still uncertain, which can make unilateral European action more costly. The crisis in the Ukraine highlighted that high reliance on Russian gas (more than 30% of EU consumption) can be a threat to energy security. This changing framework entailed a paradigm shift to climate policies that enhance growth and cost-effectiveness. This translates into setting renewable energy targets that reflects cost effective pace of deployment, completing the internal energy market,[6] as well as allowing for more market-based renewable energy deployment,[7,8] along with European led RES industry policy in the Strategic Energy Technology (SET) plan. The framework also places a strong emphasis on energy security, which is now the cornerstone of the Energy Union strategy released in February 2015.[9]

A central EU greenhouse gas emissions target by 2030

A 40% emission reduction compared to 1990 was endorsed, representing a 2,250 $MtCO_2e$ emission reduction compared to 1990. This objective is in line with the 2050 roadmap which proposes 40%, and 60% reductions by 2030 and 2040 as milestones on the way to reaching the lower-end objective of an 80% emissions reduction by 2050.

Figure 1 - EU GHG emissions and targets to 2030.



Source: I4CE – Institute for Climate Economics, based on European Commission and Eurostat data 2015.

4. EC, *A policy framework for climate and energy and energy in the period from 2020 to 2030*, 2014.
5. EC, *Conclusions on 2030 Climate and Energy Policy Framework*, 2014.
6. EC, *Progress towards completing the Internal Energy Market*, 2014.
7. EC, *Delivering the internal electricity market and making the most of public intervention*, 2013.
8. EC, *Guidelines on State aid for environmental protection and energy* 2014-2020, 2014.
9. EC, *A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy*, 2015.

A continued distinction between ETS and non-ETS sectors has been delineated. The ETS cap will decrease by 2.2% from 2020 onwards to reach a target of -43% by 2030 compared to 2005, whereas it is decreasing by 1.74% from 2013 to 2020, to achieve the 2020 target of a 21% reduction. Non-ETS sectors have a target of -30% reduction by 2030 compared to 2005.

A binding EU renewable energy target for 2030 at least cost

The 2030 energy and climate framework focuses on reducing the cost of integrating RES into the energy mix in spite of potentially slowing down the deployment of renewables as a result.

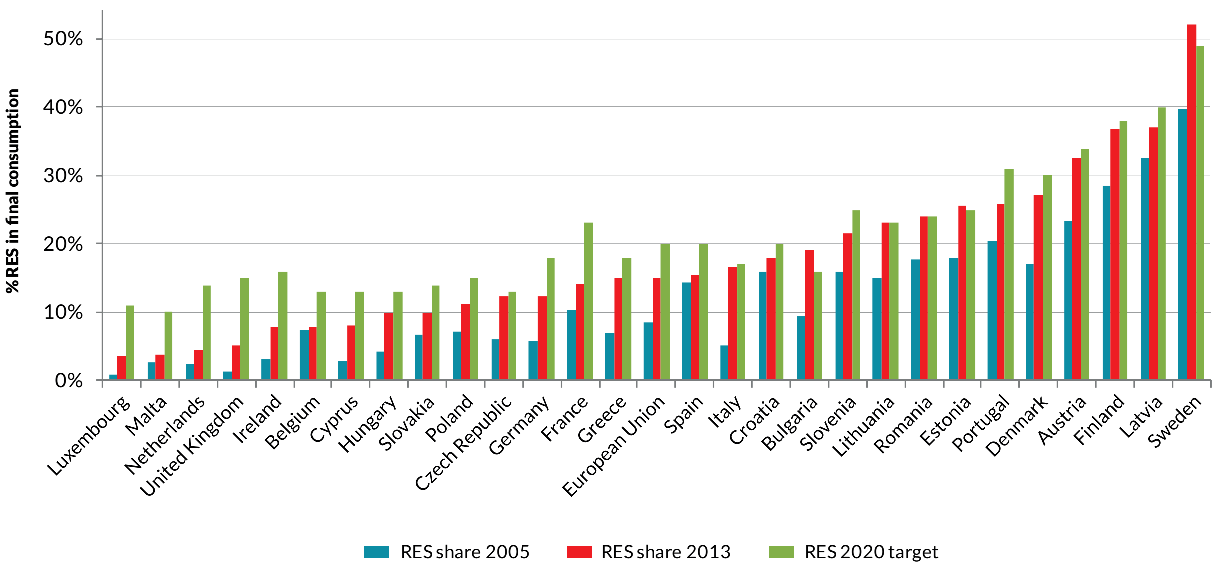
Firstly, the 2030 RES target corresponds to the model-based cost efficient target: given a 40% emission reduction target, the least cost pathway is estimated to achieve 27% renewable production in final energy consumption. Conversely, the 2020 framework's Impact Assessment set the emissions target as well as the renewable energy target exogenously. 2020 targets were also set for electricity generation (34%), energy use in transport (10%) as well as heating and cooling (21%). It gave rise to effective support mechanisms that helped to reduce risk and uncertainty, lower capital cost for the projects, and move up the learning curve. As such, a very prescriptive framework was set to ensure renewable energy deployment in all parts of the energy system and to give a clear vision to investors that renewable energy would be at the center of energy policy.

Second, national binding targets where set in the 2020 framework as illustrated in Figure 2, highlighting that strong progress has been achieved since 2005 – despite some Member States still lagging behind such as France, Netherlands, Belgium, and the United Kingdom.

Much more flexibility is afforded to Member States in the 2030 framework so as to facilitate the development of the most cost effective strategies that capitalize on national circumstances and regional potentials. National action plans should be finalised in advance of 2020 and the EU Commission committed to proposing a new Renewable Energy Package in 2016/2017. This will also include a new policy for the sustainable development of biomass and biofuels. The Energy Union package calls for more market-based deployment of renewables, in the framework of a revised electricity market designed to accommodate low carbon and capital intensive technologies.[10]

This least-cost renewable energy target will entail a continuation of a 0.70% trend in the yearly increase of the share of renewable energy observed since 2008. However, in absolute terms, as final energy consumption is expected to decrease over the period, a significant lower pace of renewable deployment is anticipated, from 5% in 2014-2020 to 2% in the 2021-2030 period, as described in Figure 3.

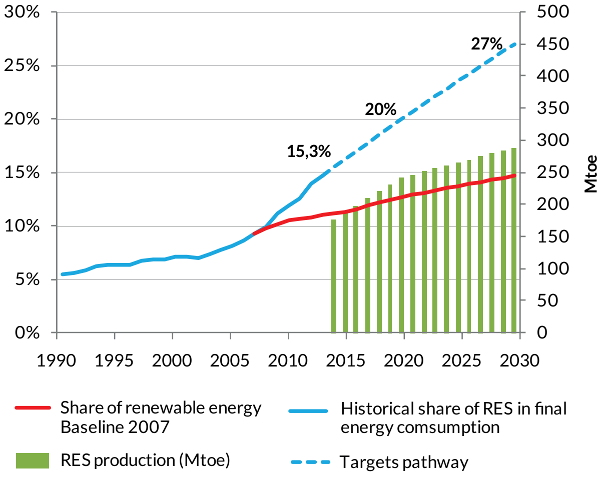
Figure 2 - Achievement of 2020 RES targets by Member States.



Source: I4CE – Institute for Climate Economics, based on European Commission and Eurostat data 2015.

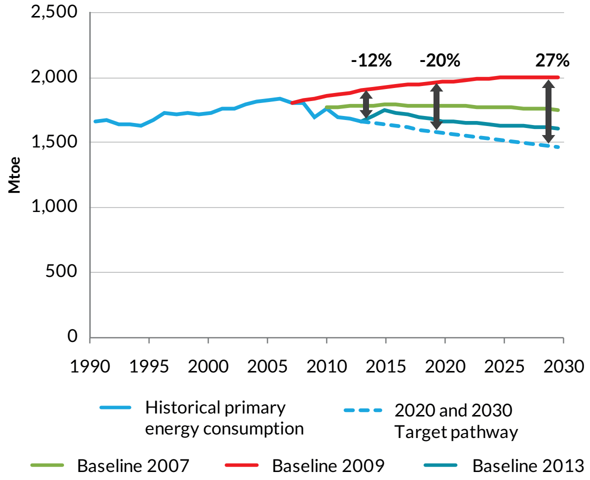
10. EC, *A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy*, 2015.

Figure 3 - Share of renewable energy in final energy consumption.



Source: I4CE – Institute for Climate Economics, based on European Commission and Eurostat data 2015.

Figure 4 - Energy efficiency targets relative to baseline scenarios.



Source: I4CE – Institute for Climate Economics, based on European Commission and Eurostat data 2015.

A non-binding EU energy efficiency target for 2030

The European Commission highlighted that, based on current national plans, the EU is on track to achieve energy savings of around 18-19% by 2020, of which one third will be due to the lower growth than expected. Tangible results have already been achieved with energy efficient buildings, labelling and performance standards. If all Member States implement the agreed legislation in a timely manner, the 2020 target could be achieved without the need for additional measures.

In its 2014 communication on the 2030 framework (released in January), the European Commission first proposed a non-binding target to conserve 25% of primary energy consumption compared to 2030 consumption levels from the 2007 PRIMES Reference scenario. Following requests from the European Council[11] in June 2014, the European Commission undertook further analysis on energy efficiency measures in light of the new priority given to energy security. While an energy efficiency target of 30% would increase the costs of the energy system by €20 billion (bn); it could also deliver substantial economic and security of supply benefits and would be a right balance between costs and benefits.[12] In October 2014, the EU Council eventually agreed on a non-binding target of 27%, subject to be reviewed in 2020 that will consider a higher target of 30%.

The Energy Union's package put a great emphasis on the potential for energy efficiency in buildings and transport, and proposed to review all relevant legislation that could underpin the 2030 target. As part of the summer package[13] in July 2015, a new proposal was released to revise the energy efficiency labelling scheme and enhance its clarity for EU consumers.

2. EU ETS EMISSIONS TARGET AND INTERACTIONS WITH ENERGY POLICIES: LESSONS FROM THE 2020 ENERGY AND CLIMATE PACKAGE

Several lessons can be drawn from the 2020 energy and climate framework.

- Firstly, the EU ETS has provided an EU-wide carbon price signal revealed by the EU ETS which complements the internal energy market.
- Secondly, renewable support policies have succeeded in overcoming strong market barriers, resulting in increasing their penetration share and a fall in the costs of these technologies from €5/W in the beginning of the century to €0.5/W in 2014 for photovoltaic. At the same time however, policy interactions have not been managed effectively, leading to a surplus undermining the EU ETS. Poorly designed support schemes for renewables have not been reconciled with the market integration agenda, unnecessarily increasing the cost of renewable deployment for the energy system and jeopardising security of supply.

11. EC, EUCO 79/14, June 27th 2014.
12. EC, *Energy Efficiency and its contribution to energy security and the 2030 Framework for climate and energy policy*, 2014.
13. EC, *Transforming Europe's energy system*, 2015.

Interactions between policies have undermined the ability of the EU ETS to drive emission reductions cost effectively

It is widely acknowledged that, complementary policies spurring emissions reductions under the umbrella of the cap reduce the demand for allowances, and drive down the carbon price (Stavins 2014, Zachmann 2012). As such, less abatement is triggered via the carbon price at the margin, offsetting the emissions reduction driven by complementary policies. If the latter are more costly, then the complementary polices are said to increase the overall cost of abatement in the short run.

Fischer and Peronas (2010) consider the theoretical effects of overlapping policies with an emissions cap. They find that when emissions are capped, overlapping policies decrease allowance prices. This result is also shown by Bohringer and Rosendahl (2010). These theoretical results are supported by various empirical studies as well. Bohringer and Keller (2011) show in their Computable General Equilibrium (CGE) analysis of the 2008 energy and climate package that a restrictive renewable energy target drives down the carbon price in the ETS sector by 50% and by an even greater share in the case of a simultaneous implementation of 20-20-20 targets.

Ex-ante assessment of interactions with the EU ETS: RES deployment accounts for 40% of the EU ETS abatement effort, but was factored in the emissions cap unlike offsets and energy efficiency

The impact assessment provided by the European Commission for the 2020 energy and climate framework[14] in 2008, gives further insights on the impact of the different complementary policies on the EU ETS. Projected emissions from EU ETS sectors in the 2007 baseline scenario were of 2,477 $MtCO_2e$ in 2020, compared to a cap of 1,816 $MtCO_2e$. The cumulative reduction effort for ETS sectors amount to 5 $GtCO_2e$ over the period from 2008 to 2020.

On the same basis and the same period, I4CE – Institute for Climate Economics (Berghmans, 2012) concludes that:

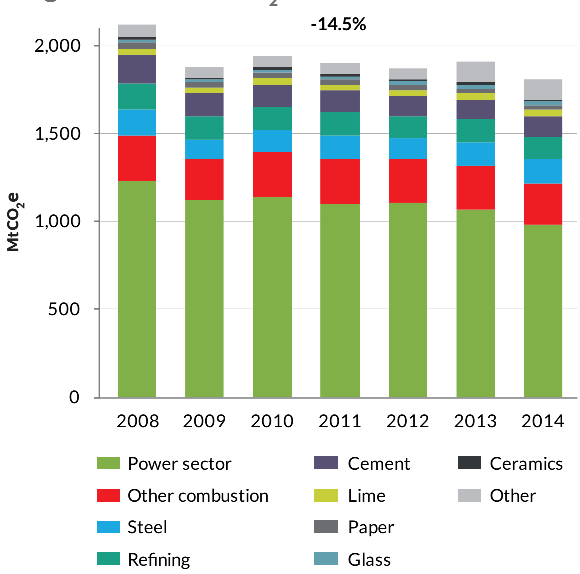
- About 2 $GtCO_2e$ are reduced through renewable energy deployment stimulated by the RES directive and targets.
- The addition of the new energy efficiency directive adds 500 $MtCO_2e$ of CO_2 emissions reduction in the scope of the EU ETS – not taken into account in the initial cap setting – and bringing the reduction needs about 2.5 $GtCO_2e$, or only 50% of the effort.
- By allowing Kyoto credits in the EU ETS in the period up to 1.65 $GtCO_2e$ (Bellassen *et al.*, 2011), the residual need to reduce domestic emissions in the EU ETS is estimated at 900 $MtCO_2e$, or only 18% of the effort.

In addition to contributing to abatement, it is worthwhile noticing that RES developments were taken into account in the ex-ante cap setting, not factoring in the impact of the Energy Efficiency Directive and international offsets.

Mid-term assessment of interactions with the EU ETS: more than 50% of the interaction impacts on surplus could have been avoided with an exhaustive ex ante assessment

Overall, EU ETS emissions reached 1,812 $MtCO_2e$ in 2014. As descripted in Figure 5, EU ETS emissions have decreased by 14.5% since the beginning of Phase II (2008-2014) when they amounted to 2,120 $MtCO_2e$. The decrease in CO_2 emissions has been particularly sharp in the power sector (-20.5%) driven by a decrease in demand, the large progresses made in terms of energy efficiency, and the penetration of RES, achieving 32.2% of EU ETS countries generation in 2014.

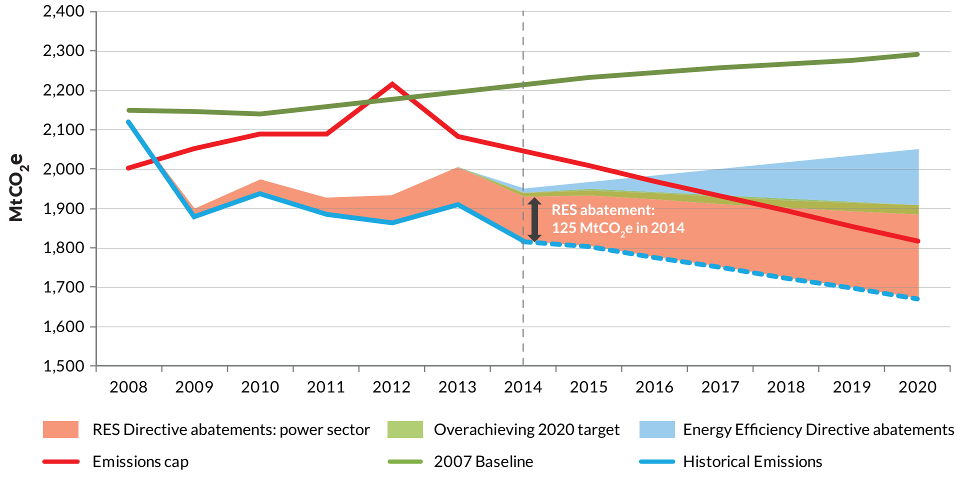
Figure 5 - EU ETS CO_2 emissions from 2008.



Source: I4CE – Institute for Climate Economics, based on EU ETS data 2015.

14. EC, *Impact Assessment - Package of Implementation measures for the EU's objectives on climate change and renewable energy for 2020*, 2008.

Figure 6 - Baseline, cap and emissions in EU ETS Phases II and III.



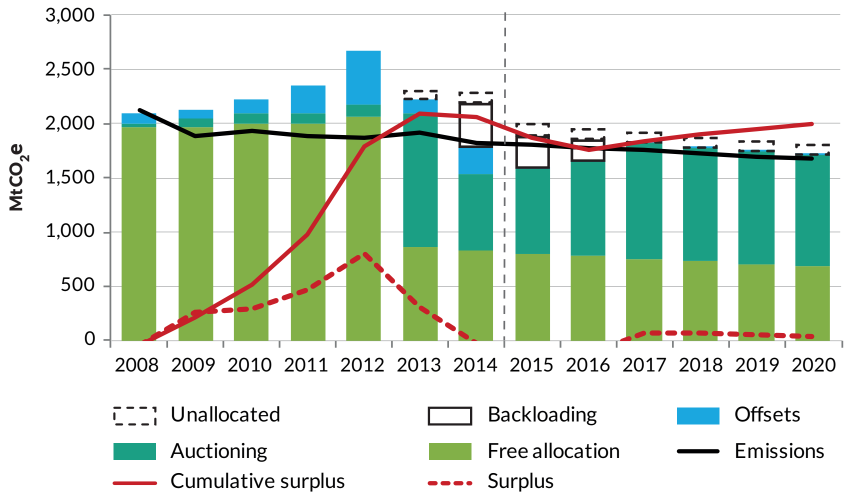
Source: I4CE – Institute for Climate Economics, estimations based on European Commission data 2015.

In 2014, CO_2 emissions are already below the 2020 emission cap of 1,816 $MtCO_2e$ and 300 $MtCO_2e$ lower than the 2007 baseline when the cap was calibrated. A mid-term assessment estimates that RES deployment has had a strong impact on emissions reduction but a low impact on the EUA surplus. Indeed, as presented in Figure 6, a counterfactual scenario based on a modelling of EU power sector without any further RES deployment after 2008 estimates that at least 125 $MtCO_2e$ were avoided in 2014 in the power sector due to the RES directive (390 $MtCO_2e$ in cumulative since 2008, and more than 1,400 $MtCO_2e$ in Phase II and III). However, these abatements were accounted for in the cap setting, and only the overachievement of the RES target may contribute to the surplus. The penetration of RES achieved 28.6% in EU-28, slightly in advance to achieve the 34% target in 2020, and the effect on the market surplus is for the moment quite negligible (roughly 10 $MtCO_2e$). Cumulatively, it is estimated to account for 120 $MtCO_2e$ in Phase III.

Abatements linked to the Energy efficiency Directive are estimated to amount to roughly 20 $MtCO_2e$ in 2014, and are estimated to reach 150 $MtCO_2e$ for the year 2020 alone (500 $MtCO_2e$ cumulatively). Therefore up until now the impact has been limited. The cumulative inflow of international credits has amounted to 1,437 $MtCO_2e$ and has played a significant role in the accumulation of the large cumulative surplus in the market amounting to 2.1 $GtCO_2e$ in 2014.

The Figure 7 shows that surplus is likely to remain high until the end of Phase III[15] even if backloaded allowances don't flow back into the market.

Figure 7 - EU ETS supply/demand balance in 2014 and projections until 2020.



Source: I4CE – Institute for Climate Economics, estimations based on European Commission data 2015.

15. Assuming a 1.4% yearly production increase in industrial sectors, 0.6% in power sector, the achievement of RES target in 2020, and without the implementation of the MSR.

Table 1 - Contributing factors to the accumulation of the surplus from 2008 until 2014 and 2020 ($MtCO_2e$).

	Energy Efficiency Directive	Kyoto Off-sets	Total surplus complemen-tary policies not considered in the cap	Downturn and other abatements	RES over Achievement of the 2020 RES target	Total surplus linked to unforeseeable developments	Back-loading	Unallocated EUAs	Total EUA surplus
2014	20	1437	1,457	1,217	10	1,227	-400	-208	2,066
2020	500	1505	2,005	1,900	120	2,020	-900	-881	2,124

Source: I4CE – Institute for Climate Economics, based on European Commission data 2015.

In 2014, the EU ETS was balanced for the first time since 2008, but this was due to the withdrawal of 400 million backloaded allowances and 110 million unallocated allowances. Otherwise, surplus would have reached 500 $MtCO_2e$ in 2014, increasing the cumulative surplus to 2.6 $GtCO_2e$.

Following these results, it is possible to estimate the contribution of different energy and complementary policies on the accumulation of the surplus, as outlined in Table 1. It appears that more than half of the impact of complementary polices on surplus (1,457 $MtCO_2e$) could have been avoided with an exhaustive ex ante assessment, whereas uncertainties underlying the demand side (overachievement of policies, downturn) have contributed only 1,200 $MtCO_2e$ to the surplus. Different adjustments (backloading and unallocated allowances) could decrease the supply by only 608 million allowances within this timeframe.

Impact of complementary policies: the EU ETS has played a residual role in emissions abatement up until now

This short term surplus, combined with the myopia of market participants and low confidence in the market has led to a fall in prices from €15/tCO_2e in 2011, to a price range of €3 - €8/tCO_2e in the 2013 - 2015 period (as shown in Figure 8). Prices have been unable to drive significant operational abatements in the power sectors, where the switch price between coal and gas generation is about €40/tCO_2e,[16] and great abatement potential remains unused. Low and highly volatile carbon prices have largely undermined the EU ETS's ability to drive investments in the development and deployment of low carbon technologies which require a credible long term price signal, consistent with the lifetime of investments.

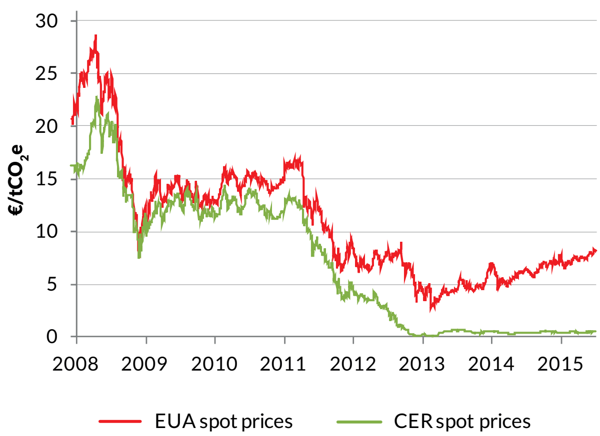
As such, the EU ETS, which was expected to be the cornerstone of the energy and climate policy, has become a residual market and has played a weak role in achieving significant emissions reduction up until now. I4CE – Institute for Climate Economics' analysis (Gloaguen *et al.*, 2013) highlights that compared to a counterfactual scenario from 2005 to 2011 more than 1 billion tons of CO_2e have been reduced in the EU ETS (as shown Figure 9), of which:

- 50% were encouraged through 2020 RES and EE policies, and
- 50% result from the economic context: economic downturn and primary energy prices.

However, there was a strong incentive for the 1.2 billion tons of CO_2e emission reductions made outside the scope of the EU ETS through Kyoto credits (CDM-JI).

When focusing on the electric sector covered by the EU ETS, the analysis of CO_2 emissions reduction factors (Berghmans *and al*, 2014) confirms the role played by economic conditions.

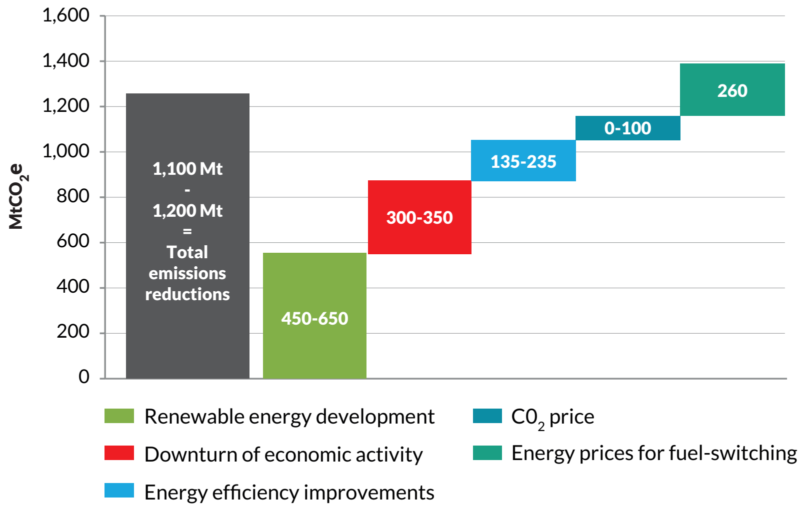
Figure 8 - EUA and CER prices from the beginning of Phase II.



Source: I4CE – Institute for Climate Economics, based on I4CE data 2015.

16. Calculated on a monthly basis in Tendances carbone, I4CE – Institute for Climate Economics.

Figure 9 - Contributions to CO_2 emissions reductions between 2005 and 2011.



Source: I4CE – Institute for Climate Economics, 2013.

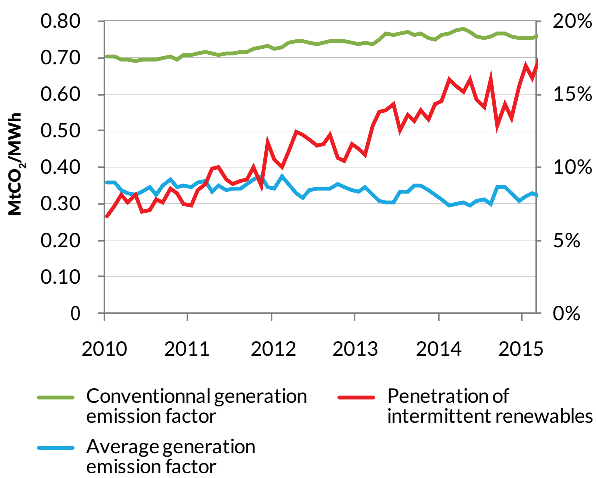
Indeed, the economic crisis and changes in primary energy prices largely influenced CO_2 emissions from the electricity sector, as well as support policies for renewables between 2005 and 2012. The study also reveals that other regulations have influenced emissions such as the carbon price in the EU ETS and the directive known as Large Combustion Plant (LCP). The energy efficiency of power plants also appears to have had an impact on emission reductions: for gas-fired and coal, the oldest plants (less efficient) have emitted more than the most recent plants.

Most RES abatements have been offset by an increase in coal generation

Since 2008, the drop in EU ETS prices has given further competitive advantage to coal generation in a context of falling coal prices and growing gas prices. While renewable energy generation (excluding hydro) has grown from 6% to 17% of monthly power generation from January 2010 to January 2015, the average carbon intensity of conventional power generation in the EU ETS countries has increased from 0.70 to 0.75 $MtCO_2e/MWh$. As such, while investments in the deployment of high abatement cost technologies (Marcantonini, 2013) have grown in Europe, the average emission factor of generation has only slightly decreased, from 0.35 to 0.32 $MtCO_2e/MWh$ in five years as described in Figure 10.

Coal generation has increased in Germany, from 130 TWh in 2010 to 148 TWh in 2014, putting pressure on the country to achieve its emission reduction target by 2020. In 2015, Germany had no choice but to enforce the closure of more than 3.2 GW of lignite generation, giving rise to stranded costs. Similarly, the UK, on risk to achieve its emission target and in order to deter investments in coal generation in the coming years, has put in place a carbon floor price.[17] Continued dysfunction of the carbon price signal is likely to spur further fragmentation of approaches to decarbonise the European power sector.

Figure 10 - Evolution of the emission factor and the share of intermittent renewable energy generation (EU ETS).



Source: I4CE – Institute for Climate Economics based on ENTSOe data, 2015.

17. The UK's Carbon Price Floor increased from £9.54/tCO_2e to 18.08/tCO_2e in April 2015, and the total carbon price, including the EU ETS price, payable by UK power stations is about €30 to €35/tCO_2 in 2015.

The way forward 2030: closing in on the efficiency frontier

Based on lessons from the 2020 energy and climate package, four main recommendations could be defined in order to manage interactions between policies to reduce the cost of the various climate and energy policies and to get closer to the efficiency frontier in the 2030 framework.

Complementary policies are necessary to decrease the long term cost of decarbonisation

The negative interactions that have occurred in the 2020 framework do not imply that complementary policies are not necessary. Even though the EU ETS is the flagship of EU climate policies, and enables the delivery of an economy-wide price signal for sectors covered by the ETS, it cannot guarantee, as a standalone policy, decarbonisation at the lowest cost. Energy efficiency abatement potential comes at low cost and even negative cost, but is facing non-price barriers, like imperfect information, split-incentives, and risk aversion of households. Not exploiting the full potential of energy efficiency measures would increase the overall cost of decarbonisation (IEA 2011).

Besides, carbon prices are not always able to encourage sufficient innovation and diffusion of clean technologies because of the inability to appropriate the full benefits of innovation (so called technology spill-over market failures, Fisher 2013). This calls for public support to develop and deploy technology options to decarbonise a lower cost in the future.

Furthermore, there are several barriers to entry that hinder the integration of low carbon technologies in power markets: investments are capital intensive and carry high risk, in addition to the fact that the intermittency of these technologies can be a strong commercial handicap in the framework of power markets designed for conventional power plants.

These core complementary policies are necessary to decrease the cost of decarbonisation both in the short and the long run, and are likely to deliver a wide range of benefits in terms of energy security, public health, term of trade, technological expertise. However, the interactions between policies must be better managed in order to reduce the cost of the various climate and energy policies and to get closer to the efficiency frontier in the 2030 framework.

RES support should be geared more toward the development of innovative technologies in order to overcome barriers to entry in power markets and to enhance the carbon price signal

It has been argued that support for renewable has been excessively geared towards deployment subsidies, amounting to €48bn in the five largest EU countries in 2010, against 315 million in public spending dedicated to R&D in the same year (Zachmann, 2014). However, increased support for further innovation in RES technologies linked to storage, production forecasting, and demand-response could enable to reduce their balancing cost linked to intermittency. Combined with a targeted market design focusing on short term flexibility, this could enable a progressive removal of barriers to entry for renewable energy. To this end, a switch towards market-based supports and long term arrangements may enable investments in renewable energy to be market driven in the mid to long term. This will in turn enhance the role of the EU ETS as an EU-wide price signal to drive abatements in a cost-effective way. This would limit the scope of interactions with other objectives, and gives EU technological leadership as stated in the Energy Union Package - "Becoming the number one in renewables".[18]

An *exhaustive ex ante* assessment of all complementary policies is necessary to calibrate the EU ETS

Unforeseen events are inherent when calibrating an emissions trading scheme's cap. However in the 2020 EU energy and climate framework, energy efficiency measures and international offsets were not taken into account in the cap setting, although they account for nearly half of the abatement effort. This has been the main contributing factor to the accumulation of the surplus. As such, a thorough ex-ante analysis, which takes into account the whole spectrum of complementary policies is of paramount importance to improve the cost effectiveness of the EU ETS. Ultimately, all the complementary targets must be taken into account by the emissions cap, whose stringency should be increased accordingly.

18. EC, *A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy*, 2015.

Greater EU ETS flexibility is needed to adapt to uncertainties relating to complementary policies

Even if complementary polices are taken into account in the cap setting, they are likely to overachieve, or underachieve on their objectives, as it is the case for the renewable energy policy. In the 2030 framework, the achievement of a 55% RES target, overachieving by 7% the 2030 target, would lead to additional 860 $MtCO_2e$ cumulative abatement in the 2021 to 2030 period as illustrated in Figure 11. Conversely, if there is no more RES integration in the power system when the 34% target is reached in 2020, additional 1,320 $MtCO_2e$ would be emitted in the 2021 to 2030 period.

As such, the achievement of policies induces additional uncertainties concerning the future demand of allowances in addition to those regarding macroeconomic trends and technology developments, and could lead to severe imbalances in the EU ETS subsequently undermining the investment framework. This calls for further flexibility in the supply of allowances in order to stabilise prices and expectations. The governance of the Energy Union, based on national plans focusing on energy efficiency improvements and RES deployment, and on the publications of indicators, can lay the basis of a dash board to oversee the EU ETS and how it interacts with other targets. This has to be complemented with ad hoc mechanisms adapting the supply accordingly. The correct balance must be found between improving predictability so as to increase investor confidence, and increasing flexibility for greater stabilisation. The Market Stability Reserve (MSR) has been proposed, and its efficiency at addressing this issue is analyzed in more detail in Chapter 2.

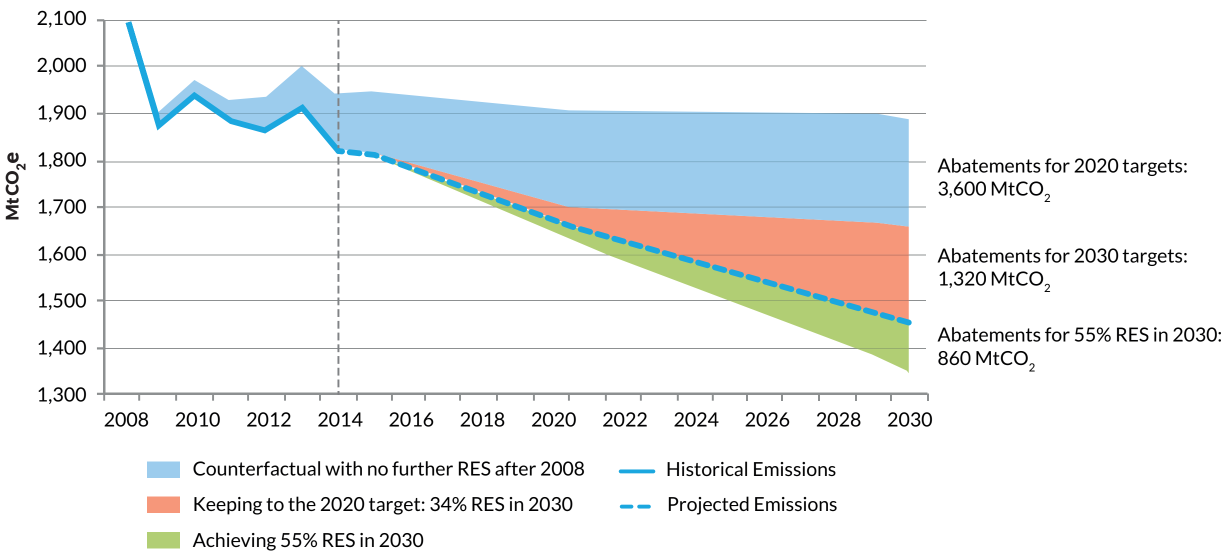
3. INTERACTIONS BETWEEN ENERGY AND CO_2 TARGETS: RESULTS BASED ON THE POLES MODEL

Defining the scenario and methodology

To assess the impact of individual energy and CO_2 targets by 2030 in the European Union, two scenarios are calculated using the POLES-Enerdata model (see Annex for a detailed description of the modelling approach, main assumptions and data sources):

- **COPEC GHG:** in this reference scenario, the only target considered is the reduction of emissions by 40% in 2030 compared to 1990 levels. This objective is split into two sub-objectives: -43% in the ETS, -30% for non-ETS sectors, both compared to 2005 levels.
- **COPEC Targets:** in this scenario, not only the emission reduction target is to be achieved, but also a 27% share of RES in gross final consumption and a 27% reduction of primary consumption (compared to the baseline derived from the PRIMES scenario in 2007, see e.g. EC, 2008).[19]

Figure 11 - Estimated EU ETS emissions based on different levels of achievement in RES policies.



Source: I4CE – Institute for Climate Economics, estimations based on European Commission data 2015.

19. For 2020, targets are defined at national level according to the countries' respective national allocation plans (NREAP and NEEAP). For 2030, targets are defined the European level and apportioned among countries according to the 2020 repartition.

Table 2 - Scenario definition and objectives for the analysis of interactions between targets.

2030	COPEC GHG	COPEC Targets	EC GHG40
Objectives			
GHG emission reduction (vs 1990)	-40.0%	-40.0%	-40%
RES share in gross final consumption	-	27.0%	-
Reduction of primary consumption	-	-27.0%	-
Achieved			
GHG emission reduction (vs 1990)	-39.2%	-39.6%	-40.6%
RES share in gross final consumption	28.6%	27.7%	26.5%
Reduction of primary consumption	-23.0%	-27.0%	-25.1%

Source: POLES – Enerdata model, 2015.

Both scenarios follow the same pathways leading to 2020 and the objectives for 2030 are illustrated in Table 2 along with the model results achieved after the simulation in POLES.

As observed, the renewable energy target of 27% is already achieved within the COPEC GHG scenario (28.6% in 2030), whereas the energy efficiency objective has not yet been met.[20] As a consequence, the COPEC Targets scenario raises the primary consumption reduction to 27% and assessing the consequences to the European energy system.

The methodological framework of POLES offers several leviers to approach the different objectives required:

- **Emission reductions:** the emission cap is defined for each year of the time period considered (linear reduction factor of 1.74%/year until 2020, then 2.2%/year) so as to meet the 2020 and 2030 objectives, and the resulting ETS price is observed. In non-ETS sectors, the emission reduction level is calibrated to achieve -40% in total in Europe vs. 1990.
- **Renewable energy sources:** support policies are implemented (feed-in tariffs and premiums, subventions). In the COPEC GHG scenario, support levels are maintained until 2020, and then stopped from 2021 onward.
- **Energy efficiency:** to achieve the energy efficiency objective, an "energy tax" is applied on all energy consumption outside the ETS.

More details about scenario assumptions are provided in the Annex.

Reference scenario results

In the COPEC GHG scenario, only the GHG emission reduction objective is implemented and achieved (39.2% reduction vs. 1990, the difference largely being the effect of offset credits). Table 3 provides an overview on several consumption, renewable energy and emission indicators for specific (2020 and 2030), and as growth rates over ten-year periods.

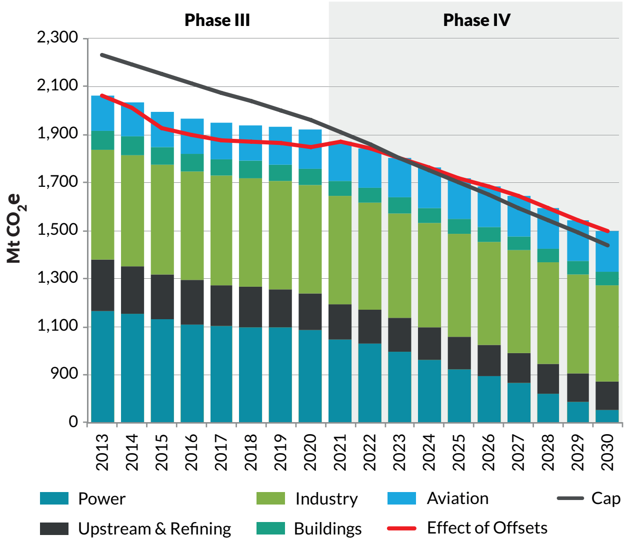
Most future indicators are in rupture with historical values. For example, while primary energy consumption had been increasing between 2000 and 2010, it is expected to decline until 2020 and thereafter. The efforts are also intensified in terms of energy intensity and carbon intensity. As for renewables, the figures show that the growth rate of RES installed capacities will not be as significant in the future as during the period 2000-2010. Despite this slowdown, the 27% European renewable objective should be met by 2030.

As a result of the emission cap to be followed in the ETS, Figure 12 illustrates the evolution of emissions in the different sectors. The power sector is responsible of 73% of total CO_2 emission reductions achieved in the ETS between 2013 and 2030. This corresponds to a 411 $MtCO_2e$ reduction and a 35% decrease over the period considered. Among other sectors, the industry and the upstream and refining sector contribute together to an additional 150 $MtCO_2$ reduction.

The carbon price path necessary to achieve these reductions is represented in Figure 13. In 2030, the carbon price in the ETS reaches $€_{2010}71/tCO_2$.[21]

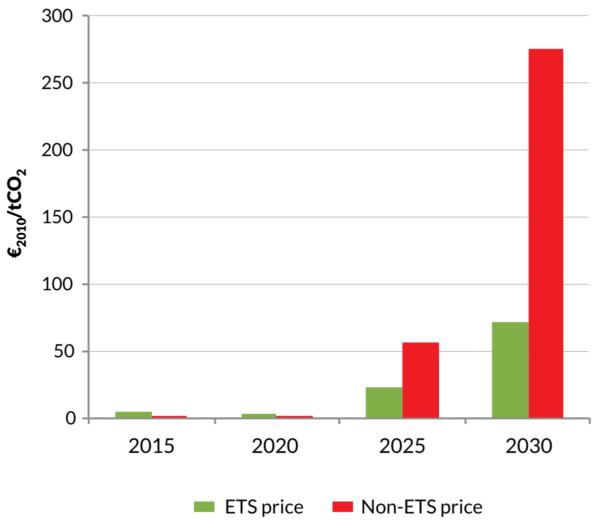
20. All POLES scenarios approach their defined objectives at the 2030 EU level. Modelling and calibration processes led to accuracy errors that result in differences between the initial targets and the final calibrated objective. This is also observed in studies where other models are used, including in the European Commission's Impact Assessment.
21. In this chapter, the Market Stability Reserve of the ETS is not considered. The effects of its introduction from 2019 are analyzed in Chapter 2.

Figure 12 - Emissions from ETS sectors in the COPEC GHG scenario.



Source: POLES – Enerdata model, 2015.

Figure 13 - CO_2 price in the ETS and carbon value in non-ETS sectors in the COPEC GHG scenario.



Source: POLES – Enerdata model, 2015.

In non-ETS sectors, a carbon value[22] of €$_{2010}$274/tCO_2 is necessary to incentivise sufficient reductions aimed at fulfilling the objective of a global 40% reduction of emissions in the EU compared to 1990 levels.

Target scenario results

In addition to the COPEC GHG scenario, where both emission reduction and renewable objectives are met, the COPEC Targets scenario aims at increasing demand-side energy efficiency to achieve the 27% objective of the European Union by 2030. The additional energy efficiency objective necessitates the inclusion of ambitious policies, valuated at levels about four times larger than in the reference scenario (average energy efficiency value[23] of €$_{2010}$896/toe applied to energy consumptions of all non-ETS sectors, vs. €$_{2010}$236/toe in COPEC GHG, see Table 4).

Table 3 - General indicators: COPEC GHG scenario.

COPEC GHG	2020	2030	2000-2010	2010-2020	2020-2030
Primary energy			+0.2%	-0.8%	-0.5%
Energy efficiency	17%	23%			
Energy intensity			-1.3%/a	-2.1%/a	-1.9%/a
RES share in gross final consumption	21%	29%			
RES electric capacity			+6.0%/a	+4.9%/a	+3.1%/a
Emissions vs 1990	-23%	-39%			
Emissions ETS vs 2005	-22%	-40%			
Emissions non-ETS vs 2005	-16%	-32%			
Carbon intensity			-2.1%/a	-2.5%/a	-3.6%/a

Source: POLES – Enerdata model, 2015.

22. The carbon value reflects the global price signal (including e.g. price of permits, carbon tax, other regulations) required in non-ETS sectors to achieve the reduction targets.
23. The average energy efficiency value represents the global valuation of efforts (e.g. policies, retrofitting, technological shifts, energy tax, etc.) required to reach a given level of energy efficiency.

Table 4 - Economic indicators: COPEC GHG and COPEC Targets scenarios.

2030 projections	COPEC GHG	COPEC Targets
ETS CO_2 price (€$_{2010}$/tCO_2)	71	10
Non-ETS CO_2 price (€$_{2010}$/tCO_2)	274	16
Energy efficiency value (€$_{2010}$/toe)	236	896
Electric renewable support policy (€$_{2010}$/MWh)	12.0	12.0
Expenditure for energy (€$_{2010}$bn/a)	1,208	1,164

Source: POLES – Enerdata model, 2015.

The energy tax applied to non-ETS sectors contributes to a decrease of their emissions. As a consequence, ETS sectors are less constrained and increase their emissions per unit of output compared to the COPEC GHG scenario, to reach the overall -40% emissions objective. Therefore the need for a high ETS carbon price is reduced significantly in the COPEC Targets scenario. The implemented energy efficiency policies in non-ETS sectors contribute to reducing the carbon price signal needed in those sectors as well. The effect of the additional energy efficiency target can be assessed further in terms of total system costs. In the following each scenario is compared to a "no policy" counterfactual scenario and Table 4 gives an overview of additional costs (compared to this counterfactual scenario) for different components of total system costs.

The implementation of a 27% energy efficiency target by 2030 is in total more costly than the unique emission reduction objective, requiring a cost increase of approximately 180%.[24]

The unique GHG emission reduction target is sufficient to reach a 27% share of RES in gross final consumption. Attaining the target for energy efficiency would require the implementation of costly energy saving policies.

4. ETS DESIGN BEYOND EUROPE: INTERACTION WITH ENERGY TARGETS

As demonstrated, when developing a climate-energy policy package it is of paramount importance to consider how other energy policies and low carbon initiatives can impact carbon pricing. Even more important still, is to ensure that an overlap in policies does not lead to lower emission reductions than if there were only one policy in place. An efficient policy mix requires management across all policies to avoid overlap and duplication. All the examined ETSs below are supported by legislation that designates an authority to be responsible for the design, implementation and enforcement of climate/energy regulations. Through regular assessments, it is possible to determine the impacts of overlapping policies and correct them to enhance positive interactions.

Table 5 - Total costs in COPEC GHG and COPEC Targets scenarios.

€$_{2010}$bn/a 2011-2030	COPEC GHG Δ / Counterfactual	COPEC Targets Δ / Counterfactual
Investment in final demand	17.0	1.4
Investment in power generation	3.8	4.0
Renewable subsidies	0.0	0.0
Energy efficiency costs	0.0	52.8
Total cost indicator	20.8	58.2

Source: POLES – Enerdata model, 2015.

24. Total costs provided are based on compound cost indicators, not directly comparable with e.g. the European Commissions' output costs. All figure are given compared to a counterfactual scenario (with no policy objectives) and therefore provide indications on additional investments and costs for the implementation of the policies the scenario focuses on. The figures include investment per sectors, costs of energy tax implementation and renewables subsidies. These investments result in energy purchases savings and carbon tax avoidance.

Table 6 - Policy interactions in Emissions Trading Schemes beyond Europe.

	California				RGGI				(Repealed) Australia ETS			
Targets	**State-wide emissions reduction target**	**ETS-cap emission reduction target**	**State-wide renewable energy target**	**State Energy Efficiency Target**	**Federal emissions reduction target**	**ETS emission reduction target**	**RGGI States' renewable energy target**	**RGGI States' Energy Efficiency Target**	**National emissions reduction target**	**ETS emission reduction target**	**National Renewable Energy Target**	**National Energy Efficiency Target**
	Reduce emissions to 1990 levels by 2020.	Gradual reduction of 0.1% each year until 2015, 3% in 2016 and 3.5% in 2020.	33% electricity generation from renewables by 2020.	0.9% annual savings though 2020.	26-28% reduction in emissions by 2025 compared with 2005 levels.	45% reduction in CO_2 emissions from power plants by 2020 compared with 2005 levels.	-	-	-5% (unconditional) to -25% (conditional)- below 2000 levels by 2020.	Total emissions covered by the carbon pricing mechanism in 2012-13, minus 38 million tonnes.	20% renewable electricity supply by 2020.	10 years energy efficiency strategy.
% total Emissions Covered by ETS	85% of California's total GHG emissions.				85% of total RGGI state CO_2 emissions from fossil fuel consumption.				60%			
ETS Governing Authority & Mandate	The California Air Resources Board (CARB) is the state's delegated regulatory authority in charge of matters concerning air pollution. They report directly to the Governor's Office in the Executive Branch of the California State Government and are responsible for the design, implementation and management of the California cap-and-trade system.				Regulations are agreed upon by member states through an MOU prior to implementation. RGGI Inc, generally supports the development of RGGI by providing technical assistance, developing system reporting and offset protocols.				The ex-Climate Change Authority's role was to set targets, conduct independent research and govern mitigation policies while the Clean Energy Regulator administrates ETS policy, tracks ETS development and manages the supply of allowances.			
ETS central or Complementary Emission Reduction Policy?	Complementary policy 29% of the 2020 target is expected to be achieved by the ETS.				Central for GHG reduction within the energy sector and complementary to other individually implemented measures taken by states in renewable energy uptake and energy efficiency.				Intended to be central.			
Ex-Ante Impact Assessment	The analysis estimates of the overall costs, savings, and cost-effectiveness of the reductions, not only for greenhouse gases (GHGs) but also for co-pollutants; Estimates of the timing of capital investments and the resulting savings; Sensitivity of the results to changes in assumed conditions Impacts on small businesses.				REMI Macroeconomic Modelling and Integrated Production Modelling conducted Ex-ante and at scheduled review periods. Assessments focus on impacts on the energy and retail market.				The regulator employs consultants to review and conduct analysis annually which informs the design of the cap and target. This helps regulators tailor the cap to market conditions.			
Ex-Post Impact Assessment & Review Period	Every five years.				Every four years.				Annually.			

Source: I4CE – Institute for Climate Economics, 2015.

REFERENCES

Berghmans N, 2012, *Energy efficiency, renewable energy and CO_2 allowances in Europe: a need for coordination.* CDC Climat Research, Climate Brief n°18

Böhringer, C. and Keller, A, 2011, *Energy Security: An Impact Assessment of the EU Climate and Energy Package*. University of Oldenburg.

Böhringer, C., and Rosendahl, K, 2011, *Greening electricity more than necessary: on the cost implications of overlapping regulation in EU climate policy*. Schmollers Jahrbuch, pg. 131, 469-492.

European Commission, 2013, *EU Energy, Transport and GHG Emissions Trends to 2050*. Available at: http://ec.europa.eu/transport/media/publications/doc/trends-to-2050-update-2013.pdf

European Commission, 2014, *Energy Efficiency and its contribution to energy security and the 2030 Framework for climate and energy.* Communication: Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52014DC0520

European Commission, 2014, *A policy framework for climate and energy and energy in the period from 2020 to 2030 - COM(2014) 15.* Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52014DC0015

European Commission, 2013, *Green Paper, A framework for 2030 energy and climate policies - COM(2013) 169.* Available at: http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52013DC0169

European Commission, 2014, *Progress towards completing the Internal Energy Market - COM(2014) 634 final.* Available at: https://ec.europa.eu/energy/en/topics/markets-and-consumers/single-market-progress-report

European Commission, 2015, *A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy - COM(2015) 80 final.* Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2015:80:FIN

European Council, 2014, *Conclusions - 26/27 June*. Available at: http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/143478.pdf

Fischer Carolyn, Newell Richard, Preonas Louis, 2013, *Environmental and Technology Policy Options in the Electricity Sector: Interactions and Outcomes.* Available at: http://www.rff.org/research/publications/environmental-and-technology-policy-options-electricity-sector-interactions

Fischer Carolyn, Preonas Louis, 2013, *Combining Policies for Renewable Energy: Is the Whole Less Than the Sum of Its Parts?* International Review of Environmental and Resource Economics vol. 4, no. 1 pg. 51-92

Gloaguen, O., and Alberola, E. 2013, *Assessing the factors behind CO_2 emissions changes over the phases 1 and 2 of the EU ETS: an econometric analysis.* CDC Climat Research Working Paper No, 2013-15.

International Energy Agency, 2011, Summing Up the Parts: Combining Policy Instruments for Least-Cost Climate Mitigation Strategies. Available at: https://www.iea.org/publications/freepublications/publication/Summing_Up.pdf

International Energy Agency, 2014, *Energy Investment Outlook.* Available at: https://www.iea.org/publications/freepublications/publication/WEIO2014.pdf

Marcantonini, Claudio and Ellerman, Denny, 2013, *The Cost of Abating CO_2 Emissions by Renewable Energy Incentives in Germany.* Available at: http://web.mit.edu/ceepr/www/publications/workingpapers/2013-005.pdf

Organisation for Economic Co-operation and of the results to changes in assumed conditions Impacts on small businesses. Available at: http://www.oecd.org/fr/gov/aligning-policies-for-a-low-carbon-economy-9789264233294-en.html

France Strategie, 2014, *European Electricity Markets in Crisis: Diagnostic and Way Forward.* Available at: http://www.strategie.gouv.fr/sites/strategie.gouv.fr/files/archives/CGSP_Report_European_Electricity_System_030220141.pdf

Stavins Robert, 2014, *Will Europe Scrap its Renewables Target? That Would Be Good News for the Economy and for the Environment.* Huffington Post. http://www.huffingtonpost.com/robert-stavins/will-europe-scrap-its-ren_b_4624482.html

Zachmann Georg, 2012, G*reen growth and green innovation.* Investment and growth in the time of Climate Change, European Investment Bank and Bruegel

Zachmann Georg, 2012, *When and how to support renewables? Letting the data speak.* Available at: http://bruegel.org/2014/02/when-and-how-to-support-renewables-letting-the-data-speak/