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Study on the inclusion of transport and buildings in an EU emission trading system

Authors
Climact: Pieter-Willem Lemmens, Quentin Jossen, Pascal Vermeulen
Öko Institute: Hauke Hermann

Vlaanderen
is energie en klimaat

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Beleidssamenvatting (NL)

Belangrijkste conclusies

1. Deze studie onderzoekt de impact van een Europees emissiehandelssysteem voor transport en gebouwen op de verwachte koolstofprijs, emissiereducties, energie-uitgaven, veilingopbrengsten en administratieve kosten voor het Vlaams Gewest.

2. De studie concludeert dat een emissiehandelssysteem voor transport en gebouwen vanaf 2026 slechts tot beperkte bijkomende emissiereducties zal leiden tegen 2030, tenzij de koolstofprijs wordt toegelaten om tot een hoog prijsniveau te stijgen. Zonder flankerende beleidsmaatregelen zou emissiehandel voor transport en gebouwen een koolstofprijs van ver boven €100/t $CO_{2eq.}$ nodig hebben om de vereiste reducties voor 2030 te bereiken. Indien emissiehandel zou worden gecombineerd met andere, flankerende maatregelen – zoals wordt voorgesteld door de Europese Commissie – verwachten we lagere maar nog steeds aanzienlijke prijzen tussen €70 en €100/t $CO_{2eq.}$

3. Er zijn twee belangrijke redenen waarom een koolstofprijs van meer dan €100/t $CO_{2eq.}$ tot slechts bescheiden reducties zou leiden in transport en gebouwen tegen 2030. Beide sectoren worden gekenmerkt door niet-markt barrières, die bepaalde reducties belet ook wanneer deze kostenefficiënt worden dankzij een koolstofprijs. Daarnaast worden beide sectoren ook gekenmerkt door lange investeringscycli, wat betekent dat bepaalde reductiemaatregelen tijd nodig hebben om geïmplementeerd te worden. Beide elementen leiden tot een lage prijselasticiteit op korte termijn. De elasticiteit wordt wel verwacht te stijgen op de langere termijn naarmate de koolstofprijs investeringen bijstuurt, en op voorwaarde dat niet-markt barrières worden opgeheven via flankerende maatregelen.

4. Omwille van deze redenen zullen andere beleidsinstrumenten een centrale rol moeten spelen in het behalen van de vereiste reducties in transport en gebouwen tegen 2030. Emissiehandel zou in parallel geïmplementeerd kunnen worden, maar kan enkel verwacht worden een ondersteunende rol te spelen tot en met 2030. Het zou de vereiste intensiteit van andere beleidsinstrumenten kunnen verlagen doordat prijssignalen beter

in lijn worden gebracht met de reductiedoelstelling, en het zou opbrengsten genereren die gebruikt kunnen worden om andere beleidsmaatregelen te financieren.

5. Indien emissiehandel wordt toegepast, zou dit echter ook leiden tot een stijging van brandstofkosten, met een risico op ongewenste sociale en economische gevolgen. Uitgaande van constante verbruiksniveaus – dus vooraleer rekening te houden met eventuele reducties in het energieverbruik noch met het hergebruik van veilingopbrengsten – verwachten we dat het voorstel van de Europese Commissie de energieuitgaven van Vlaamse huishoudens verhoogt met gemiddeld €322 (+19%) tot €460 (+28%) per jaar in 2030 (o.b.v. een prijsvork van €70 tot €100/t $CO_{2eq.}$). Gemiddeld gezien ligt de impact lager in absolute termen (maar hoger in relatieve termen) voor huishoudens met een laag inkomen, en *vice versa* voor huishoudens met een hoog inkomen. Het voorstel zou ook een impact hebben op Vlaamse bedrijven in de diensten- en transportsector. Voor niet-ETS industrie en landbouw wordt de verwachte impact zeer laag ingeschat, gezien het merendeel van hun energieverbruik niet onder het toepassingsgebied van het systeem zou vallen.

6. We verwachten dat het voorstel van de Commissie tussen €5 en €8 miljard aan veilingopbrengsten zou genereren voor het Vlaams Gewest in de periode 2026-2030. Twee derde hiervan zou komen van huishoudens en eenderde van niet-huishoudelijke energieverbruikers. De gemiddelde beschikbare veilingopbrengst per gezin zou variëren tussen €214 en €346 per jaar (o.b.v. een prijsvork tussen €70 en €100/t $CO_{2eq.}$). Het voorstel van de Commissie vereist dat alle veilingopbrengsten worden gebruikt om emissiereducties in de betrokken sectoren te ondersteunen en om de impact op kwetsbare huishoudens en bedrijven te beheersen.

7. De administratieve last wordt verwacht beperkt te zijn, rond €3 miljoen per jaar voor Vlaamse bedrijven en €325k per jaar voor de Vlaamse bevoegde autoriteit.

Context en doel van deze studie

De Europese Unie heeft zich ertoe verbonden om zijn broeikasgasemissies (BKG-emissies) te reduceren met minstens 55% (t.o.v. 1990). Transport en gebouwen zullen een aanzienlijke bijdrage moeten leveren aan deze doelstelling. In deze context heeft de Europese Commissie een wetsvoorstel gepubliceerd om een emissiehandelssysteem toe te passen op de transport- en gebouwensector, als onderdeel van zijn bredere "*Fit for 55%*" pakket, en dit als één van de instrumenten om emissies in deze sectoren te reduceren.

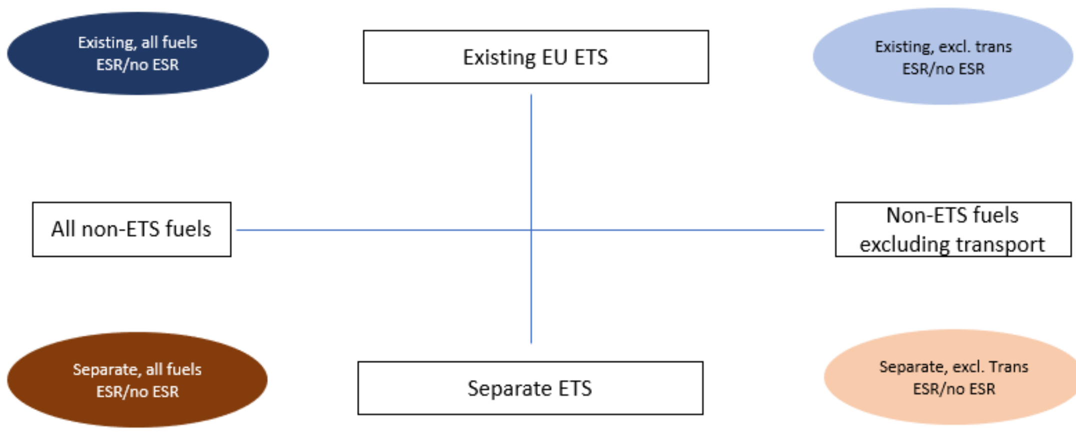
Deze studie analyseert de verschillende opties om emissiehandel toe te passen op de transport- en gebouwensector op het EU niveau, alsook hun respectievelijke impact op de verwachte koolstofprijs, Vlaamse emissieniveaus, de energiefactuur van Vlaamse bedrijven en huishoudens, en administratieve kosten. De studie werd uitgevoerd tussen februari en augustus 2021. Dit betekent dat een groot deel van de analyse werd uitgevoerd voor de publicatie van het Commissievoorstel, op basis van een aantal assumpties over hoe een dergelijk emissiehandelssysteem zou worden georganiseerd. Doorheen deze studie wordt toegelicht in welke mate deze assumpties overeenkomen met het uiteindelijke voorstel, en welke impact eventuele verschillen kunnen hebben op de uitkomst.

Onderzochte beleidsopties

Voor deze studie werden verschillende beleidsopties onderzocht, rekening houdend met de onderstaande dimensies zoals afgebeeld in Figuur 1:

1. Of het brandstofverbruik van huidige niet-ETS sectoren zou worden opgenomen in het bestaande EU ETS, of dat er een apart, gescheiden system zou worden opgericht;
2. Of de gedekte sectoren daarnaast ook nog gedekt zouden worden door de Effort Sharing Verordening (ESR) of niet. Onder de **no ESR scenario's** wordt verondersteld dat de betrokken sectoren niet langer worden gedekt door de ESR, wat zich zou vertalen in minder (ambitieuze) andere reductiemaatregelen. Onder deze scenario's zou emissiehandel toegepast worden als het voornaamste instrument om bijkomende reducties in de transport- en gebouwensector te verwezenlijken. Onder de **ESR scenario's** wordt verondersteld dat de ESR wordt verdergezet, en zou emissiehandel voor transport en gebouwen worden geïmplementeerd in parallel met eerder dan ter vervanging van andere beleidsmaatregelen;

3. Of het toepassingsgebied zich zou uitbreiden tot brandstoffen in alle niet-ETS sectoren, dan wel of transportbrandstoffen uitgesloten zouden worden.



Figuur 1: Onderzochte beleidsopties

Het voorstel van de Commissie komt het sterkste overeen met het “Separate, all fuels, ESR” scenario (donkerrood in Figuur 1): er wordt een apart systeem voorgesteld voor transport en gebouwen, en deze sectoren blijven daarnaast gedekt door de ESR. Het belangrijkste verschil tussen dit scenario en het Commissievoorstel is dat **de Commissie voorstelt om al het brandstofverbruik in de landbouwsector en de niet-ETS industrie uit te sluiten van het nieuwe emissiehandelssysteem**. We verwachten echter dat de impact van dit verschil op de verschillende conclusies van deze studie beperkt zijn, gezien het beperkte aandeel van deze sectoren in de totale, energie-gerelateerde niet-ETS emissies.

Verwachte koolstofprijsniveaus

Onze analyse toont aan dat de koolstofprijs sterk kan variëren (van €40 tot meer dan €100/t $CO_{2eq.}$) in functie van de gebruikte assumpties. In het algemeen zijn er twee factoren die de verwachte koolstofprijs bepalen:

- **Apart systeem vs. uitbreiding van het bestaande EU ETS?** *Ceteris paribus* leidt een apart systeem voor transport en gebouwen tot hogere koolstofprijzen voor de transport- en gebouwensector, en lagere prijzen voor de elektriciteits- en industriële sectoren. De onderliggende reden is dat de marginale reductiekosten wordt verwacht hoger te liggen in de transport- en gebouwensector t.o.v. de elektriciteits- en industriële sectoren.

- **Verderzetting vs. stopzetting van de ESR?** *Ceteris paribus* leidt een verderzetting van de ESR tot lagere koolstofprijzen, gezien lidstaten sterker worden aangezet om bijkomende reductiemaatregelen te behouden of zelfs aan te scherpen, zowel op nationaal als op Europees niveau. Zonder dergelijke flankerende maatregelen zouden hogere prijzen nodig zijn om gelijkaardige reducties te verwezenlijken (gezien in dat geval sommige hefbomen onderbenut blijven).

Of transport al dan niet wordt gedekt door het systeem heeft in onze analyse geen sterke impact op de prijs. Dit is omdat we hebben gewerkt met de hypothese dat de emissieruimte voor elke sector zou worden bepaald o.b.v. de PRIMES beleidsscenario's van de Commissie, waaronder slechts beperkte reducties worden voorzien voor transport. Daardoor zou niet enkel de vraag (= emissies) maar ook het aanbod (= emissierechten) voor transport slechts beperkt dalen.

Op basis van onze analyse kan de laagste koolstofprijs verwacht worden indien het huidige EU ETS wordt uitgebreid en de ESR wordt verdergezet. Onder dit scenario wordt de koolstofprijs verwacht te variëren tussen €40 en €70/t $CO_{2eq.}$ tegen 2030[1]. In het geval van een apart systeem zonder verderzetting van de ESR zouden prijzen stijgen tot (ver) boven €100/t $CO_{2eq.}$ tegen 2030.

Tabel 1: Verwachte koolstofprijzen in 2030

Bestaand ETS of apart systeem	Verderzetting ESR	Prijsvork [in €/t $CO_{2eq.}$]
Bestaand	Ja	€40 tot €70
	Nee	€70 tot €100
Apart	Ja	
	Nee	Boven €100

Onder het **separate, all fuels, ESR scenario**, hetgeen het meeste aansluit bij het voorstel van de Commissie, verwachten we een koolstofprijs tussen €70 en €100/t $CO_{2eq.}$ tegen 2030 [2].

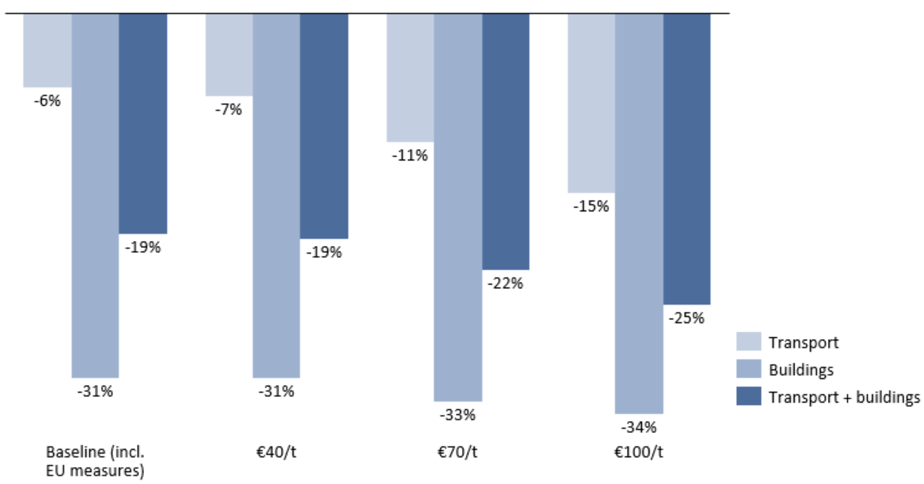
[1] Deze optie zou wel leiden tot hogere prijzen voor sectoren die nu al worden gevat door het EU ETS.

[2] Dit ligt in dezelfde ordegrootte als de gemodelleerde koolstofprijs onder het MIX-CP scenario van de Commissie. In dit scenario – waarbij wordt uitgegaan van een beperkte aanscherping van flankerende beleidsmaatregelen – zou de koolstofprijs €80/t bedragen tegen 2030. Onder het MIX scenario van de Commissie – waarbij wordt uitgegaan van een sterkere aanscherping van flankerende beleidsmaatregelen - zou de koolstofprijs €48/t bedragen tegen 2030.

Impact op emissieniveaus

No ESR scenario's: emissiehandel als het voornaamste beleidsinstrument

Onze analyse geeft aan dat indien er enkel wordt gerekend op emissiehandel om de vereiste, bijkomende reducties in de transport- en gebouwensector te verwezenlijken, dit zou leiden tot zeer hoge koolstofprijzen. Dit wordt duidelijk in onze 'Separate, no ESR' scenario's: onder deze scenario's zouden emissies van deze sectoren zelfs met een koolstofprijs van €100/t $CO_{2eq.}$[3] slechts 35% dalen tegen 2030 (t.o.v. 2005), wat onvoldoende is om het emissieplafond van het systeem te verzekeren (dat 43% onder het 2005 emissieniveau zou liggen). Er zou dus een nog hogere koolstofprijs nodig zijn onder deze scenario's om te verzekeren dat emissies reduceren in lijn met het emissieplafond. Ook op het Vlaams niveau zouden zelfs met een koolstofprijs van €100/t $CO_{2eq.}$, emissies in de transport- en gebouwensector reduceren met slechts 25% tegen 2030 t.o.v. 2005 (-15% voor transport en -34% voor gebouwen).



Figuur 2: Vlaamse reducties onder de 'no ESR' scenario's (emissiehandel als voornaamste beleidsmaatregel) – 2030 vs. 2005

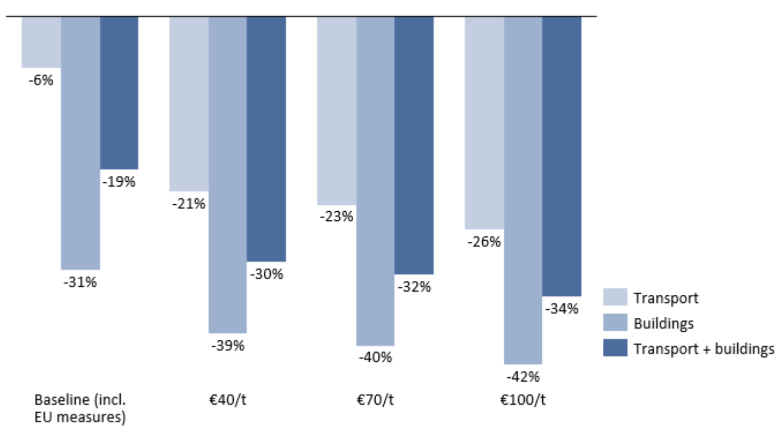
Er zijn twee belangrijke redenen waarom zelfs een prijs van €100/t $CO_{2eq.}$ tot slechts bescheiden reducties zou leiden in deze sectoren tegen 2030. Ten eerste wordt zowel de transport- als de gebouwensector gekenmerkt door niet-marktbarrières die de koolstofprijs beletten om bepaalde reductiepotentiëlen te ontsluiten, zelfs indien deze kostenefficiënt zijn. Daarnaast

[3] Bovenop bestaande heffingen

worden beide sectoren gekenmerkt door langere investeringscycli[4], wat betekent dat sommige reductiemaatregelen tijd nodig hebben om geïmplementeerd te worden. Beide elementen leiden tot een lage prijselasticiteit op korte termijn. Gezien het emissiehandelssysteem pas in 2026 zou starten, is de verwachte impact tegen 2030 dan ook beperkt tenzij prijzen worden toegelaten om (ver) boven €100/t $CO_{2eq.}$ te stijgen. De impact van emissiehandel kan echter wel toenemen op langere termijn, gezien de prijselasticiteit wordt verwacht hoger te liggen op langere termijn, op voorwaarde dat niet-marktbarrières worden aangepakt via flankerende maatregelen.

ESR scenario's: emissiehandel in combinatie met ambitieuze, bijkomende maatregelen

Indien emissiehandel wordt toegepast in aanvulling op in plaats van ter vervanging van andere beleidsinstrumenten, verwachten we sterkere reducties per prijsniveau: met prijzen tussen €40 en €100 per ton, zouden emissies reduceren met -21% tot -26% voor de transportsector, en tussen -39% en -42% voor de gebouwensector.



Figuur 3: Vlaamse reducties onder de 'ESR' scenario's (emissiehandel in combinatie met flankerend beleid) – 2030 vs. 2005

Deze resultaten tonen aan dat andere beleidsmaatregelen een centrale rol zullen moeten spelen om de vereiste reducties tegen 2030 te verwezenlijken, en dat men van emissiehandel – indien toegepast – enkel een ondersteunende rol mag verwachten. Bovendien zouden bijkomende reducties ten gevolge van emissiehandel slechts beperkt zijn 5 jaar na

[4] Een voertuig wordt doorgaans elke 15 jaar vervangen, een verwarmingssysteem elke 15 tot 20 jaar, en een gebouw wordt doorgaans slechts elke 30 jaar (of zelfs langer) grondig gerenoveerd.

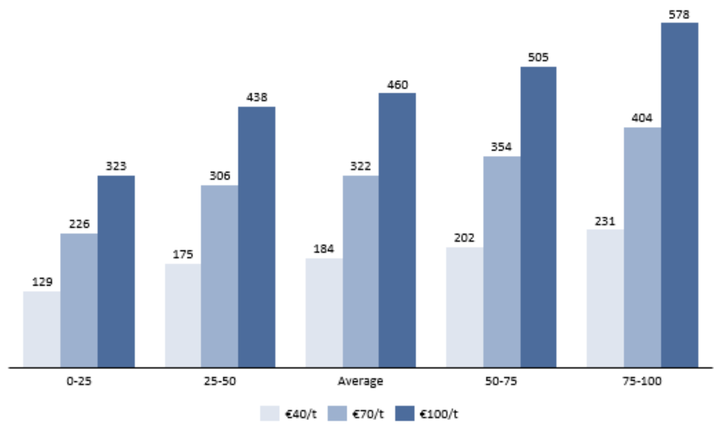
inwerkintreding, voor dezelfde redenen als hierboven vermeld. Niettemin kan emissiehandel andere beleidsinstrumenten ondersteunen door te verzekeren dat marktsignalen beter zijn afgestemd op de klimaatdoelstellingen, waardoor de vereiste intensiteit van andere instrumenten vermindert. Het zou ook het risico op terugkaatseffecten verminderen (gezien de prijzen van alle fossiele brandstoofen zou stijgen) en bepaalde reducties stimuleren die moeilijk worden gestuurd door andere types beleidsinstrumenten (zoals bv. laadgedrag bij plug-in hybride voertuigen). Ten slotte genereert emissiehandel publieke middelen die kunnen gebruikt worden om andere, flankerende maatregelen te financieren (zie onder).

Impact op Vlaamse huishoudens en bedrijven

Onze analyse toont aan dat de verwachte prijsniveaus onder een nieuw emissiehandelssysteem een **significante impact kunnen hebben op energieprijzen**, en dat bezorgdheden over de sociale gevolgen dan ook gerechtvaardigd zijn[5].

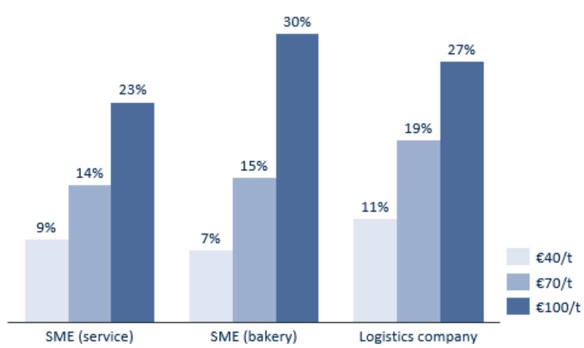
Aan constante verbruiksniveaus zouden **jaarlijkse energieuitgaven voor transport en verwarming stijgen met €184 (+11%) onder een €40/t $CO_{2eq.}$ koolstofprijs**. Voor de 25% huishoudens met het laagste inkomen zou de impact lager zijn in absolute termen (€129 per jaar) maar licht hoger in relatieve termen (+12%). Voor huishoudens met het hoogste inkomen zou de impact hoger zijn in absolute termen (€231 per jaar) maar lager in relatieve termen (+10,5% per jaar). Deze trends worden versterkt onder hogere koolstofprijzen. **Onder een koolstofprijs van €100/t $CO_{2eq.}$ – en uitgaande van constante verbruiksvolumes – zouden jaarlijkse energieuitgaven stijgen met gemiddeld €460 per jaar (+29%), gaande van €323 (+31%) voor huishoudens met de laagste inkomens tot €578 (+27%) voor huishoudens met de hoogste inkomens.** Er moet echter worden opgemerkt dat het steeds gaat over gemiddelden, op basis van gemiddelde uitgaven per inkomenscategorie, en dat er sterke verschillen kunnen zijn binnen elke inkomenscategorie.

[5] Bezorgdheden inzake competitiviteit lijken minder relevant in dit geval, gezien de sectoren die het meest zijn blootgesteld aan het risico op koolstofweglekkage (m.a.w. sectoren met een relatief hoge energie-intensiteit en handelsintensiteit, zoals landbouw en industrie) niet gedekt zouden worden door het nieuwe ETS.



Figuur 4: verwachte impact van een koolstofprijs op de energieuitgaven voor transport en verwarming van Vlaamse huishoudens – per inkomenskwartiel (in €/jaar)

Inzake bedrijven zal het voorstel van de Commissie **voornamelijk een impact hebben op KMO's en logistieke bedrijven**, gezien het toepassingsgebied is beperkt tot gebouwenverwarming en transportbrandstoffen. **De impact op niet-ETS industrie en landbouw wordt zeer gering ingeschat**, gezien het overgrootte deel van hun energieverbruik niet gedekt zal worden door het systeem. Voor KMO's en logistieke bedrijven zouden energieuitgaven stijgen met 9-11% onder een koolstofprijs van €40/t $CO_{2eq.}$, en met 23%-30% onder een koolstofprijs van €100/t $CO_{2eq.}$. De relatieve impact is hoger voor grote verbruikers, gezien zij momenteel een lagere prijs per eenheid energie betalen, en daardoor de relatieve impact van een koolstofprijs[6] groter is.



Figuur 5: impact van een koolstofprijs op energieuitgaven van Vlaamse bedrijven (% stijging)

[6] in veronderstelling dat deze 100% wordt doorgerekend

Er kunnen echter verschillende hefbomen ingezet worden om eventuele ongewenste sociale gevolgen hiervan te beperken. Ten eerste kunnen energie efficiëntie en toegang tot betaalbare, koolstofvrije energie helpen om huishoudens en bedrijven te beschermen tegen hoge koolstofprijzen. Daarnaast kunnen Vlaamse veilingopbrengsten een belangrijke rol spelen in het tegengaan van ongewenste sociale gevolgen ten gevolge van deze stijging in energieuitgaven. De ingeschatte veilingopbrengsten worden hieronder in meer detail besproken.

Verwachte veilingvolumes en -opbrengsten

Naast het creëren van een koolstofprijs genereert emissiehandel ook opbrengsten die kunnen gebruikt worden om o.a. verdere reducties te ondersteunen en eventuele sociale gevolgen bij te sturen. Onder het Commissievoorstel – en onder de assumptie dat de voorgestelde verdeelsleutel op EU niveau ook intra-Belgisch wordt toegepast – zou het Vlaams Gewest iets meer dan 100 miljoen emissierechten veilen onder het nieuwe systeem tussen 2026-2030. Na rekening te houden met de impact van het voorgestelde Sociaal Klimaatfonds[7], **zouden de totaal beschikbare veilingopbrengsten tussen €5-7,9 miljard liggen voor de gehele periode 2026-2030**, afhankelijk van de uiteindelijke koolstofprijs[8].

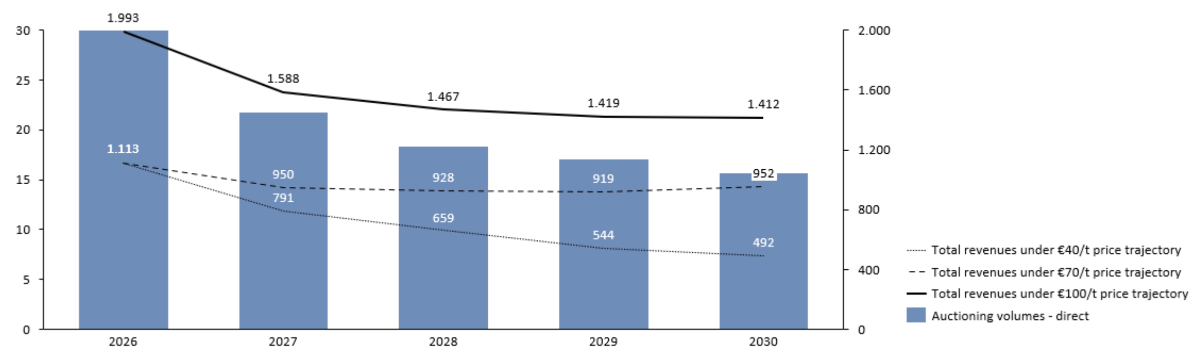
Op basis van de huidige verhouding van emissies zouden ongeveer twee derde van de opbrengsten voortkomen van huishoudens (residentiële gebouwen en personenvervoer), en eenderde van vrachtvervoer en niet-residentiële gebouwen. Indien tweederde van de opbrengsten worden gebruikt om huishoudens te ondersteunen, zou het gemiddeld beschikbare bedrag per huishouden neerkomen **op €158 per jaar onder een koolstofprijs van €40/t $CO_{2eq.}$, €218/t per jaar onder een prijs van €70/t $CO_{2eq.}$, en €346 per jaar onder een prijs van €100/t $CO_{2eq.}$.**

Het voorstel van de Commissie vereist dat alle opbrengsten worden gebruikt om de transitie in de transport- en gebouwensector te ondersteunen alsook om de sociale gevolgen van

[7] Het Vlaams Gewest zou €1270 miljoen bijdragen aan het Sociaal Klimaatfonds maar zou ook tot €850 miljoen kunnen ontvangen (in geval de bijdragen en ontvangsten worden gebaseerd o.b.v. het Vlaamse aandeel in de Belgische transport- en gebouwenemissies). De netto-bijdrage zou dus €420 miljoen bedragen over de gehele periode 2026-2030.

[8] Op basis van de veronderstelde prijstrajecten die leiden tot een koolstofprijs van €70 tot €100/t $CO_{2eq.}$ tegen 2030.

emissiehandel bij te sturen. Hierbij moet de focus liggen op kwetsbare huishoudens, kwetsbare (micro-)bedrijven en kwetsbare transportgebruikers. Dit moet onder meer gebeuren via het Sociaal Klimaatfonds.



Figuur 6: verwachte Vlaamse veilingvolumes (linkeras, in miljoen rechten) en opbrengsten (rechteras, in € miljoen)

Impact op administratieve lasten

In het algemeen wordt verwacht dat de administratieve lasten van een nieuw emissiehandelssysteem beperkt zullen zijn. Voor de gedekte entiteiten zou de administratieve kost gemiddeld €11 300 bedragen. Voor publieke autoriteiten zou de administratieve kost gemiddeld €1 650 per gereguleerde entiteit bedragen, waarvan ± 75% voor het beheer van de MRV nalevingscyclus, en ± 25% voor het beheer van het register en exploitanttegoedrekeningen.

Het Commissievoorstel stelt brandstofleveranciers aan als de te reguleren entiteiten onder het nieuwe systeem. Onder deze aanpak zou het Vlaams Gewest 264 bijkomende entiteiten moeten reguleren (waarvan 231 erkende entrepothouders en 33 aardgasleveranciers). Bijgevolg zou **de totale administratieve kost ± €3 miljoen bedragen voor Vlaamse bedrijven, €325k voor de Vlaamse bevoegde autoriteit en €110k voor de federale registeradministrateu**r.

Executive summary (EN)

Main conclusions

1. This study assesses the impact of emission trading in the transport and building sector on expected carbon prices, emission reductions, energy expenditures, auctioning revenues and administrative costs.

2. It concludes that implementing an emission trading system for the transport and buildings sector as of 2026 will only result in limited additional reductions by 2030, unless carbon prices are allowed to get to high levels. Without complementary policies, emission trading in the transport and buildings sectors would need prices well beyond €100/t $CO_{2eq.}$ to achieve the required reductions for 2030. When emission trading would be combined with other, complementary policies – which is the approach proposed by the European Commission – the analysis expects lower but still considerable price levels, between €70 and €100/t by 2030.

3. There are two main reasons why a carbon price < €100/t would only lead to modest reductions in the transport and buildings sectors by 2030. Both sectors are characterized by non-market barriers which prevent the carbon price from triggering some abatement potentials even if they are cost-efficient. Secondly, both sectors are also characterized by longer investment cycles, which means that some reduction options require time to implement. Both elements lead to low short-term price elasticities. Price elasticities are expected to increase over the longer run as the carbon price would steer investments, provided that non-market barriers are addressed through other policies.

4. For these reasons, other policy instruments will have to play a central role in achieving the required emission reductions by 2030. Emission trading could be implemented in parallel, but can only be expected to play a supportive role until 2030: it could lower the required intensity of other policy instruments as market signals would be more aligned with the reduction objective, and would generate revenues which could be used to finance other policies (see below).

5. However, if implemented, it would also increase fuel prices, with a risk of adverse social and economic impacts. At constant consumption levels – before taking into account reduction measures and/or any recycling of auctioning revenues - the Commission's proposal is expected to increase Flemish household expenditures for heating and transport fuels between €322 (+19%) and €460 (+28%) per year in 2030 (based on a price range of €70/t to €100/t). On average, the impact is expected to be lower in absolute terms but higher in relative terms for lower-income households, and *vice versa* for higher income member states. The proposal would also impact energy expenditures of Flemish companies in the service and logistics sector. For non-ETS industry and agriculture, the impact is expected to be negligible as the bulk of their energy consumption would be excluded from the ETS scope.

6. We expect the Commission's proposal to raise between €5 and €8 billion in auctioning revenues for Flanders for the period 2026-2030. Two-thirds would come from households and one-third from non-household consumers. The average available auction revenue per household would range between €214 and €346 per year (based on a price range of €70 to €100/t). The proposal requires that these revenues are used to support emission reductions in the covered sectors and to address social impacts on vulnerable households and companies.

7. The administrative burden is also expected to be limited, at €3 million per year for Flemish businesses and €325k per year for the Flemish Competent Authority.

Context and aim of the study

The European Union is committed to reduce its greenhouse gas (GHG) emissions by at least 55% by 2030 (compared to 1990). The transport and buildings sectors will have to make a significant contribution to this objective. In this context, the European Commission has published a legislative proposal to apply emission trading to the transport and buildings sectors, as part of its broader "Fit for 55%" package, and as one of the instruments to reduce emissions in these sectors.

This study looks into the possible options to implement emission trading on the transport and buildings sectors at the EU level, as well as their respective impacts on the expected carbon price, Flemish emission levels, energy bills of Flemish businesses and households, and administrative costs. The study was performed between February and August 2021. This means a large part of the analysis was carried out prior to the publication of the Commission's proposal, based on a number of assumptions about how such an emission trading system could be organized. Throughout the study, it is indicated to what extent these assumptions are aligned with the final proposal, and how any differences might impact the outcome.

Main policy options assessed

In this study, different policy options have been assessed based on the following dimensions as illustrated in **Error! Reference source not found.**:

1) Whether fuels of the current non-ETS sectors would be included in the existing EU ETS, or whether a separate scheme would be created;
2) Whether the sectors concerned would still be covered by the Effort Sharing Regulation (ESR) or not. Under the **no ESR scenarios**, the Effort Sharing Regulation is discontinued, which is assumed to translate into less (and less ambitious) complementary policies. Emission trading is used as the primary tool to leverage additional emission reductions in the transport and buildings sector. Under the **ESR scenarios**, the Effort Sharing Regulation is continued, and emission trading is introduced for transport and buildings alongside rather than instead of complementary reduction policies.
3) Whether the scope of the new scheme would include the fuels of all non-ETS sectors, or would exclude the fuels in the transport sector.

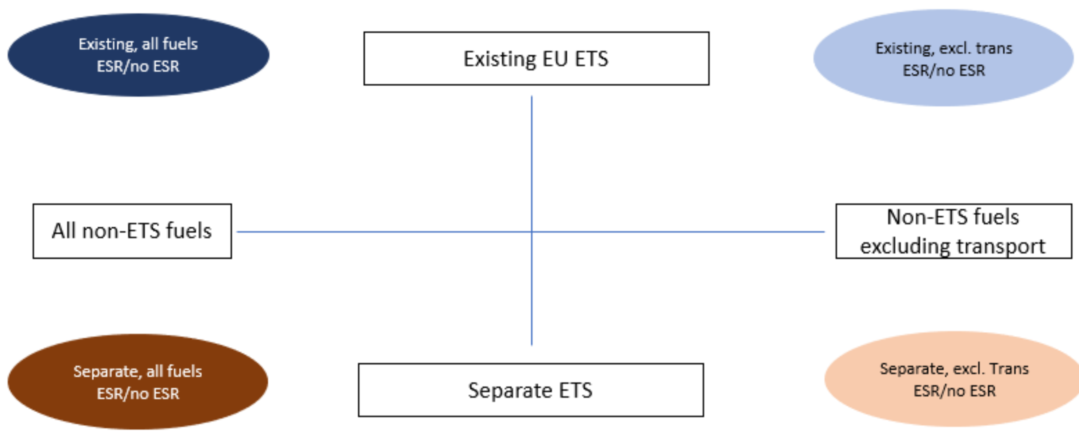


Figure 1: Policy options assessed

The proposal of the Commission is most closely aligned with the "Separate, all fuels, ESR" scenario (dark red in **Error! Reference source not found.**): a separate scheme would be created for both building and transport fuels, and these sectors would continue to be covered by the ESR. The main difference between this scenario and the Commission's proposal is that **the Commission proposes to exclude all fuel use in the agricultural and non-ETS industry sectors**. However, the impact of this change on the different conclusions of this study are expected to be limited, given the relatively small share of these sectors in total non-ETS, energy-related emissions.

Expected carbon price levels

The analysis shows that the resulting carbon price could vary significantly depending on the assumptions used (from €40 to beyond €100/t by 2030). Overall, two main factors have an impact on the expected carbon price:

- **Separate or not from the existing EU ETS system?** *Ceteris paribus*, a separate scheme (as opposed to one system which would include all sectors) would lead to higher prices for the transport and buildings sectors, and lower prices for the power and industry sectors. Underlying reason is that the marginal reduction cost is expected to be higher in buildings and transport compared to industry and power;

- **Covered or not by the ESR?** *Ceteris paribus*, a continuation of the ESR would lead to lower prices, as member states will be incentivized to maintain and even strengthen complementary GHG reduction policies. Without such complementary policies, higher carbon prices would be necessary to achieve the same emission reduction (as some levers remain underused).

Whether transport is included in the system or not does not have a significant impact on the price in our analysis. This is because we have assumed the ‘transport cap’ to be based on the Commission’s PRIMES scenarios, which only foresees modest reductions for this sector. Therefore, although demand (emissions) are expected to decrease only moderately for this sector, so is supply.

Based on our analysis, the lowest carbon price can be expected under an extension of the current EU ETS and a continuation of the ESR. Under this scenario the carbon price is expected to range between €40 and €70/t by 2030[9]. In the case of a separate scheme without continuation of the ESR, prices would increase beyond €100/t by 2030.

Table 1: expected carbon prices by 2030 per scenario

<table>
<tr><th>Existing ETS or separate scheme?</th><th>Maintained in ESR</th><th>Price range [in €/t $CO_{2eq.}$]</th></tr>
<tr><td rowspan="2">Existing</td><td>Yes</td><td>€40 to €70</td></tr>
<tr><td>No</td><td rowspan="2">€70 to €100</td></tr>
<tr><td rowspan="2">Separate</td><td>Yes</td></tr>
<tr><td>No</td><td>Beyond € 100</td></tr>
</table>

Under the **separate, all fuels, ESR scenario**, which is most closely aligned with the Commission’s proposal, prices are expected to range between €70 and €100 by 2030[10].

[9] Whereas this option leads to the lowest prices for the transport and buildings sectors, it would increase prices for sectors which are currently already included in the EU ETS.
[10] This is in the same order of magnitude as the modelled carbon price under the Commission’s MIX-CP scenario. In this scenario – which assumes a limited increase in complementary policies – the carbon price would reach €80 by 2030. Under the Commission’s MIX scenario – which assumes a medium intensity increase in complementary policies – the carbon price would reach €48 by 2030.

Impact on emission levels

No ESR scenarios: emission trading as the primary reduction policy

Our analysis suggests that relying solely on emission trading to achieve the required reductions in these sectors would lead to very high carbon prices. This becomes most clear in our 'Separate, no ESR' scenarios: under these scenarios, even under a €100/t carbon price[11] emissions at the EU level would only reduce with -35% by 2030 (compared to 2005), which is insufficient to respect the cap of the system (which would be 43% below 2005 emission levels). A significantly higher carbon price would thus be required under these scenarios for emissions to decrease in line with the cap. Similarly, at the Flemish level, even with a €100/t carbon price, emissions in the transport and building sector would only decrease by 25% below 2005 emission levels (-15% for transport and -34% for buildings respectively).

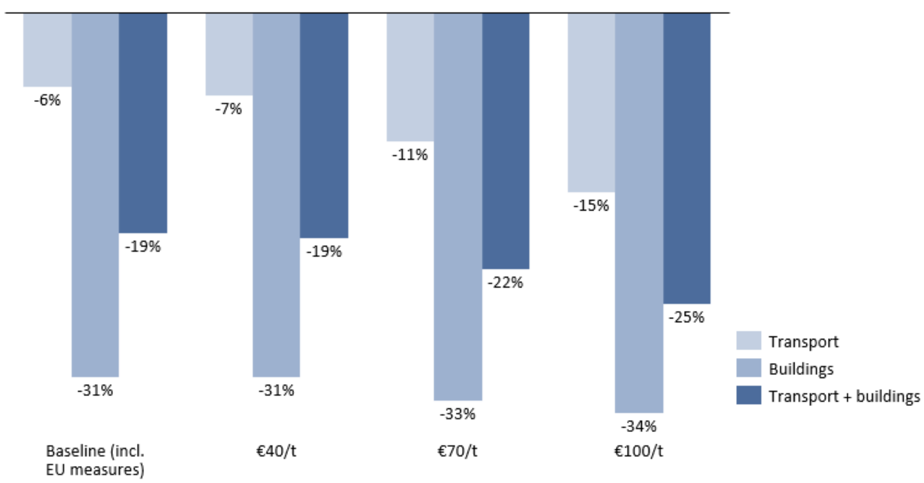


Figure 2: Flemish reductions under 'no ESR' scenarios (emission trading without complementary policies) – 2030 vs. 2005

There are two main reasons why even a €100/t carbon price would only lead to modest reductions in these sectors by 2030. Both the buildings as the transport sector are characterized by non-market barriers which prevent the carbon price from triggering some abatement potentials even if they are cost-efficient. Secondly, both sectors are also

[11] On top of existing taxes and levies

characterized by longer investment cycles[12], which means that some reduction options require time to implement. Both elements lead to low short-term price elasticities. As the emission trading system would only start to operate in 2026, the expected impact by 2030 is therefore limited, unless prices are allowed to increase (significantly) beyond €100/t. The impact of emission trading would however increase over time, as price elasticities are considered to be higher in the longer run, provided that non-market barriers are addressed through complementary measures.

ESR scenarios: emission trading in combination with ambitious, complementary policies

If emission trading is used as an addition to rather than to replace other types of reduction policies, Flemish emission reductions are expected to be steeper with similar carbon price levels: with prices ranging from €40 to €100 per tonne, emissions are projected to decrease between -21% and -26% for the transport sector and between -39% and -42% for the buildings sector.

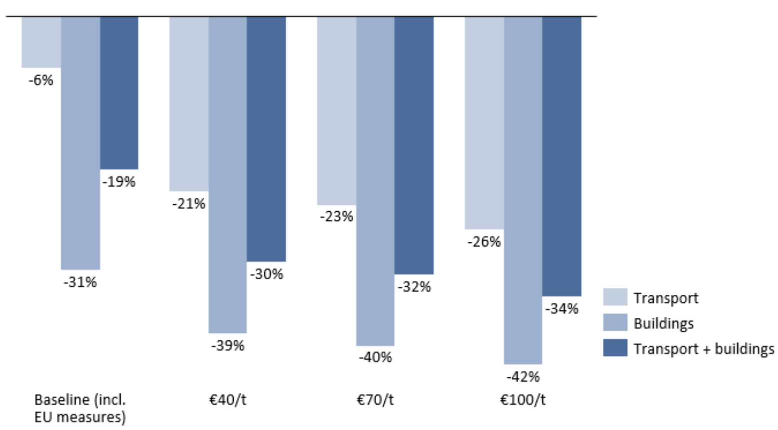


Figure 3: Flemish reductions under 'ESR' scenarios (emission trading in combination with complementary policies) – 2030 vs. 2005

These results show that complementary policies will have to play a central role in achieving the required emission reductions by 2030, and that emission trading – if implemented – can only be expected to play a supportive role. Additional reductions from a carbon price on top of

[12] Typically, a vehicle is replaced every 15 years, a heating system every 15 to 20 years, and a building is renovated every >30 years.

other policies would still be limited after five years of operation, for the same reasons mentioned above. However, emission trading could support other policies by ensuring that market forces are better aligned with the climate objectives, thereby reducing the required intensity of other policy instruments. It would also reduce the risk of rebound effects (as it is expected to increase all fossil fuel prices) and can trigger reduction potential which is difficult to address through other policy types (e.g. PHEV charging behaviour). Finally, it generates public revenues which can be used to finance other, complementary policies (see below).

Impact on Flemish households and companies

Our assessment finds that the price levels which are expected under the new emission trading system will have **a significant impact on energy prices**, and concerns about the social impact are thus justified[13].

At constant consumption levels, under a **€40/t carbon price, annual energy expenses for heating and transport would increase on average with €184 (+11%).** For the 25% lowest income households, the impact is lower in absolute term (€129 per year), but slightly higher in relative terms (+12%). For highest income members, the impact is higher in absolute terms (€ 231) but slightly lower in relative terms (+10,5%). These trends are amplified under higher carbon prices**. Under a €100/t carbon price – and assuming constant consumption levels - annual expenditures would on average increase with €460 (+29%), ranging from €323 (+31%) for lowest and €578 (+27%) for highest income households.** It should be noted that these are average numbers, based on average energy expenditures per income quartile. Within each income quartile, significant differences may occur.

[13] Competitiveness concerns seem to be less relevant in this case, as the sectors which could be exposed to a risk on carbon leakage (that is, sectors with a relatively high energy-intensity and trade intensity, such as agriculture and industry) would not be covered by the new ETS.

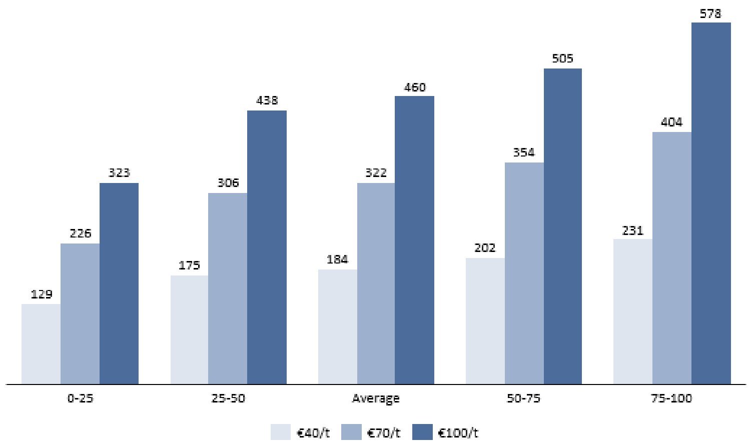


Figure 4: expected impact of a carbon price on Flemish household energy expenditures for transport and heating – per income quartile (in €/year)

If emissions trading is implemented, several levers could be used to mitigate potential social adverse impacts. First of all, increased energy efficiency and access to affordable, zero-carbon energy could help shield households and companies from high carbon costs. Furthermore, Flemish auctioning revenues can play an important role in mitigating undesired social impacts from this increase in energy expenditures. The potential of auctioning revenues is described in more detail below.

For companies, **the Commission's proposal is expected to impact mainly SME's and logistic companie**s, as the scope is limited to building heating and transport fuels. **Non-ETS industry and agriculture is not expected to be significantly impacted**, as the bulk of their energy consumption would not be covered. For SME's and logistic companies, heating and transport fuel expenditures would increase with 9-11% under a €40/t carbon price, and 23-30% under a €100/t carbon price. The relative impact is higher for high-volume consumers as they currently pay lower prices per energy unit, and therefore the relative impact of a carbon price (when assuming 100% cost pass-through) is higher.

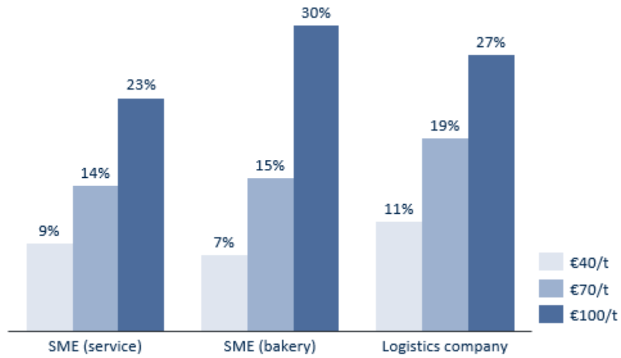


Figure 5: impact of a carbon price on Flemish businesses energy expenditures for transport and heating (% increase)

Expected auctioning volumes and revenues

Next to setting a price on carbon, emission trading generates revenues which can be used i.a. to further support the transition and address social impacts (= the double dividend). Under the Commission proposal – and assuming the proposed distribution key is also applied for intra-Belgian revenue distributions – Flanders is expected to auction a little over 100 million allowances under the new system between 2026-2030. After accounting the impact of the Social Climate Fund[14], **total available revenues would range between €2,6 –7,9 billion over the period 2026-2030**, depending on the carbon price[15].

Based on current shares in emissions, about two thirds of the revenues would come from households (residential buildings and passenger transport), with freight transport and non-residential buildings accounting for the other third. Assuming that two thirds of auctioning revenues could be used to support households, the **average available auctioning revenues per household would be on average €158 per year under a €40/t carbon price trajectory, € 218/t under a €79/t price trajectory, and €346 per year under a €100/t carbon price trajectory**[16].

[14] Flanders would contribute €1270 million but could also receive up to €850 million from the Social Climate Fund, assuming it would contribute and received based on its share in Belgian transport and buildings emissions. Its net contribution would thus be €420 million for the period 2026-2030
[15] Based on the assumed price trajectories leading to a carbon price of €70 to €100/t by 2030.
[16] Including revenues available via the Climate Social Fund

The Commission's proposal requires revenues to be used to support the transition in the transport and buildings sector as well as to address the social impacts of the emission trading system, with a specific focus on vulnerable households, vulnerable micro-enterprises and vulnerable transport users, i.a. via the newly proposed Social Climate Fund.

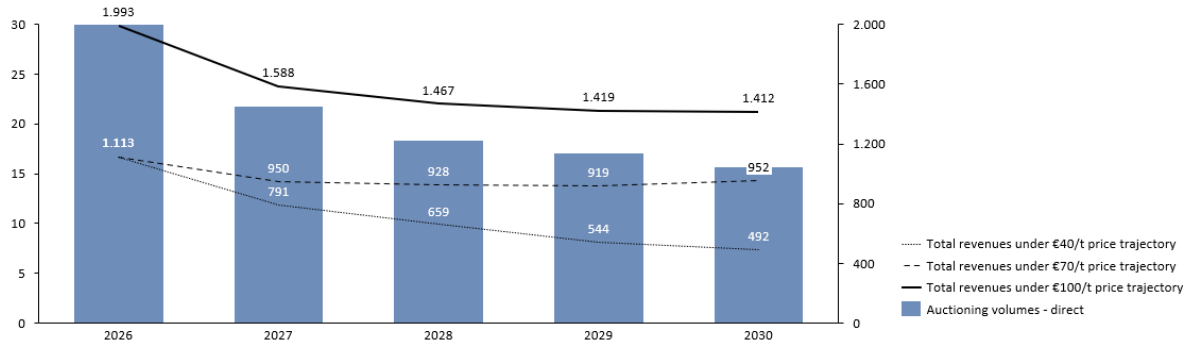


Figure 6: expected Flemish auctioning volumes (left axis, in million allowances) and revenues (right axis, in € million)

Impact on administrative burdens

Overall, **administrative costs from the new emission trading system are expected to be low**. For covered entities, the annual administrative cost would average €11.300. For public authorities, the annual cost would amount up to €1.650 per regulated entity, of which +- 75% for administering the MRV compliance cycle, and the other 25% for managing the registry and operator accounts.

The Commission's proposal identified fuel suppliers as the regulated entities under the new emission trading system. Based on this approach, Flanders would have to administer 264 additional entities (of which 231 registered fuel depot operators and 33 natural gas suppliers). As a result, **the total annual administrative cost is expected to be +- €3 million for Flemish businesses, € 325k for the Flemish competent authority and € 110k for the Federal registry administrator.**

Introduction

Policy context

In its European Green Deal, the Von der Leyen Commission has proposed to increase the EU's climate objective from at least -40% to at least -55% emission reductions by 2030 (compared to 1990), in order to put the EU on track towards net-zero greenhouse gas emissions by 2050 (European Commission, 2019a). Both the 2050 as the increased 2030 objectives have since been legally enshrined in the EU Climate Law, on which a provisional agreement was reached by the Council and the European Parliament in April 2021 (European Commission, 2021a).

In September 2020, the Commission published it's 2030 Climate Target Plan and accompanying Impact Assessment, in which it outlined how it intends to achieve the increased 'at least -55%' reduction objective for 2030 (European Commission, 2020b). In July 2021, it proposed its "Fit for 55%" package, including 12 legislative proposals to reshape the EU's climate and energy policy framework up to 2030.

One of the key initiatives under the "Fit for 55%" package is the proposal to extend emission trading to the buildings and transport sectors (European Commission, 2021b). Since 2008[17], the EU's power and heavy industry sectors have been covered by an EU wide emission trading system (the EU ETS), under which emissions have been reduced by 40% by 2020 (compared to 2008). Under the Commission's proposal, the EU ETS would be extended to cover maritime emissions, and a similar but separate system would be implemented for the transport and buildings sectors. This system would start to operate as of 2026.

Aim of this study

In order to prepare for the decision-making process following the Commission's proposal, the Flemish Climate and Energy Administration has asked Climact and Öko Institute to study the different policy options for extending emissions trading for transport and buildings and their

[17] After a test phase in 2005-2007

respective impacts on a number of parameters. The specific research questions in this study are:

1) To what extent can emission trading trigger additional reductions in the transport and buildings sector, and how does it relate to other types of policies such as regulations, subsidies, ...?

2) What are the different main policy options to apply emission trading to these sectors? And what is their expected impact on:
    a. the expected carbon price?
    b. emissions in the Flemish transport and buildings sectors?
    c. The expected auctioning revenues for the Flemish Region?
    d. The energy costs of Flemish households?
    e. The competitiveness of Flemish companies?
    f. The administrative burden on the Flemish administration and entities covered by the ETS?

The analysis for this study was mainly performed between February and June 2021, when the details of the Commission's proposal were still unknown. The analysis was carried out based on a number of assumptions about how such an emission trading system could be organized. After the publication of the Commission proposal, limited updates are made where relevant. Throughout the study, it is indicated to what extent these assumptions are aligned with the final proposal, and how any differences might impact the outcome.

Structure of the study

The study is structured as follows:

In **chapter 1**, we explain what role emission trading can play in decarbonizing the buildings and transport sector, and how it could interact with other policy instruments. In **chapter 2**, we look into how an emission trading system for these sectors can be developed, with a qualitative assessment of the different design options. Based on these different options, we will propose 4 main policy scenarios, with each time two variants. In **chapter 3** we explore what the carbon price could be under these different policy scenarios, based on a supply-demand balance model that was developed for this study. In **chapter 4** we assess the expected impact on the emissions of the Flemish buildings and transport sector, taking into account both the expected carbon price as well as the impact of other types of policies. **Chapter 5** looks into the expected impact on the energy bills of households and companies, and what auctioning revenues could be expected to mitigate undesired impacts. In **chapter 6**, we provide an analysis of the expected administrative burden of emission trading for transport and buildings, both for the regulated entities as for the Flemish competent authority. We conclude the study with main messages and recommendations.

1) The potential role for emission trading in decarbonizing the transport and buildings sector

The main aim of implementing emission trading is to create a carbon price, which in turn should incentivize market actors to reduce their consumption of carbon intensive products and/or to switch to climate-friendly alternatives. Therefore, to assess the merits of emission trading, we will assess the merits of carbon pricing in general, and for the transport and buildings sectors in particular.

a. The overall role for carbon pricing in the policy mix

Climate change is considered to be a market failure, as the damage caused by greenhouse gas emissions is not borne by the emitter. As a result, the emitter has little incentive to abate its emissions to reduce the damages incurred by those emissions. Therefore, there is a broad agreement among economists that internalising this externality by putting a price on carbon should play a central role in the climate policy mix (World Bank, 2021a, IEA, 2019; OECD, 2016, IEA, 2011, LSE, 2011).

The main advantage of carbon pricing is that it ensures that market forces are aligned with climate objectives, sending a clear signal to producers, consumers and investors. Although the cost of certain low-emission technologies have decreased significantly over time (and are expected to decrease even further), emission-intensive, fossil-based products and technologies often remain cheaper compared to their low/zero-emissions alternatives. This means that – in the absence of a carbon price – other policies will have to be implemented to overcome prevailing market forces and to force the market in the direction of climate-friendly alternatives. Such policies could be subsidies (closing the price gap between the fossil incumbent and the low-carbon or zero-emission alternative) or regulations (forcing actors to use the climate-friendly alternative, even if this is more expensive compared to the fossil incumbent). However, as long as such other policies are counteracted by market forces, their cost will increase as reduction objectives become more and more ambitious, putting pressure on public finances (in case of subsidies). The advantage of a carbon price is that it would increase the efficiency of other policies, would reduce pressure on public finances, and would distribute costs based on the ‘polluter pays’ principle.

Another benefit of carbon pricing is that it directly addresses consumption levels. Whereas other policy tools such as regulations or targeted support are effective in targeting investment decisions, they are less effective in affecting day-to-day behaviour. For example, ambitions standards can make products or processes more energy efficient, but they do not impact consumption levels of those products. A carbon price is more effective to this end, although the impact varies between sectors due to differing price elasticities and available short-term alternatives (for example, for transport and buildings, the contrary seems to apply, as described below).

A third benefit of carbon pricing is that it is technology-neutral: it leaves it up to the market to decide how abatement can be achieved most efficiently. This makes it a cost-efficient instrument, whereas other instrument types often require policy makers having to ‘pick winners’, which aren’t necessarily the most cost-efficient solutions. In addition, it also ensures that all abatement options are incentivized, even those that might not directly come to mind of policy makers and are therefore not directly targeted by other policies (for example heating behaviour in buildings or driving behaviour in transport).

Finally, a carbon price raises revenues that can be used to finance other policy measures and/or correct any undesired distributional impacts of the transition. This is referred to as the ‘double dividend’. These revenues are also aligned with the needs for the transition: they are high due to a broad tax base in the beginning of the transition when there is still a lot of abatement to be done, and will decrease in the long term as the economy decarbonizes.

On the other hand, there are also some major shortcomings associated with carbon pricing. Firstly, some sectors are characterized by **non-market barriers**, which prevent reduction measures from being implemented even if they are cost-efficient from a strictly economical point of view. Secondly, carbon pricing is not effective in supporting **technological development**. A large part of the solution to the climate crisis lies in the use of new, climate-friendly technologies. However, new technologies are often expensive in the beginning of their development phase, which means they will not be picked up by a carbon price alone. Other policy instruments are needed to fully develop such technologies. In the absence of complementary policies to address non-market barriers and to support technological development, some reduction levers will remain underused , , and a higher carbon price would be needed to meet the required reductions. Therefore, there is a wide agreement that carbon pricing should be combined with complementary policies to address non-market barriers and support technology development, in order to achieve deep reductions in the most cost-efficient manner (World Bank, 2021, IEA, 2011).

Finally, there are concerns that a carbon price increases overall costs for households and businesses, which in turn might lead to **undesired social and/or economic impacts**. These impacts could be (at least partially) mitigated through specific support and compensation mechanisms, such as exemptions, free allocations, financial compensations or direct support to increase energy efficiency and/or decarbonize the energy mix. However, such mechanisms have their own challenges: they increase complexity, require finance (which might exceed expected auctioning revenues), could undermine the carbon price signal that the system was initially intended to create, and increase the risk of windfall profits. Therefore, if implemented, such compensation mechanisms should be designed carefully to provide appropriate levels of support to vulnerable households and companies, while limiting complexity and avoiding adverse effects.

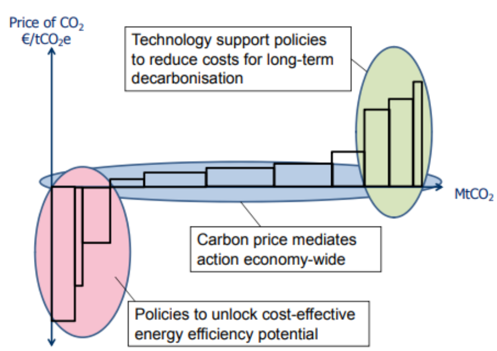


Figure 7: the role of carbon pricing in the overall policy mix. Source: IEA (2011)

The EU and its member states have been implementing carbon pricing – either through emission trading or through carbon taxes – since 1990. A primary example is the EU ETS, which has been operating since 2005. In recent years, the carbon price under this system has increased significantly, from €7 per tonne in 2017 to recent highs above €61/t. The increased carbon price has improved the competitive situation of highly efficient natural gas power plants compared to inefficient coal-fired power plants, thereby supporting the decarbonisation of the EU power grid. The higher carbon price has also made renewables more competitive, reducing the need for subsidies. At the same time, a carbon leakage framework has been developed to protect the competitiveness of industry against regions subject to other climate policies.

b. The role of carbon pricing in the transport and buildings sector

Whereas there is broad agreement that carbon pricing has an important role to play to decarbonize our society, the question is whether it also has a role to play in the decarbonisation of the transport and buildings sectors. Several EU member states have already implemented – or are planning to implement – carbon pricing instruments for these sectors. Scandinavian countries introduced carbon taxes on these sectors already in the early 90's. More recently, other EU member states such has France, Germany, the Netherlands and Austria have also started or are starting to implement carbon pricing policies in the transport and buildings sector. However, there are differing opinions among policy experts whether carbon pricing is a suitable instrument to drive emission reductions in those sectors: whereas some consider it to be an essential part of the policy mix (see e.g. BPIE, 2021, Agora Energiewende, 2021), others have warned that it would generate little additional reductions while risking significant, adverse social impacts (see e.g. Cambridge Economics, 2020, BEUC, 2021). In this section, we assess what carbon pricing can and cannot do to drive emission reductions in transport and buildings.

Aligning market signals: for the transport and buildings sectors, electrification is considered to be one of the main levers to achieve deep emission reductions. Currently however, in many EU member states including in Belgium, electricity prices are much higher than the price of fossil heating fuels. This is partly due to a difference in commodity prices, but is further amplified due to relatively low taxes and levies on fossil heating fuels, and relatively high taxes and levies (and other non-commodity costs) on electricity. The resulting price difference implies that market forces discourage rather than incentivize the switch from fossil-based heating systems to electrified systems. Both the European Commission (European Commission, 2020c) as well as the OECD (OECD, 2021) have repeatedly recommended Belgium to align energy taxes with CO_2 emissions. Introducing a carbon price can be an effective (although not the only possible) solution to reduce the price gap between electricity and fossil heating fuels, and therefore better align market forces with decarbonisation efforts in the buildings sector. For the transport sector, the problem of counterproductive market signals is less pronounced, as transport fuels are already covered by significant excise duties.

Steering consumption behaviour/operational decisions: whereas in general carbon prices are expected to effectively steer consumption behaviour and operational decisions, literature suggests that this is less the case in the buildings and transport sector due to low short-term price elasticities (see e.g. Cambridige Econometrics, 2020, Alberini *et al.*, 2021, BPIE, 2021, ICF *et. al*, 2021, VTPI, 2013). Two main reasons are given for this: both sectors are characterized by important non-market barriers (see below), and the limited availability of short-term alternatives to reduce fossil fuel consumption: in buildings, the impact of carbon pricing on heating behaviours is expected to be limited, as a certain level of heating is required to meet a minimum level of comfort. Although there still remains some potential for improved rational energy use, main reductions of fossil fuel consumption would thus have to come from investments rather than changes in operations/consumption behaviour such as deep energetic renovations and the switch to fossil-free heating systems. Due to longer investment cycles, these measures take time to implement. A similar reasoning can be made for transport: overall mobility demand is not easily reduced, as people need to get to work, to school, buy groceries, etc. …. The potential for short term reductions in fuel consumption by e.g. switching to softer transport modes is overall considered to be limited. Like in buildings, most reductions are expected from technology shifts (e.g. switch to electric vehicles) and structural changes such as shorter supply chains, an efficient spatial planning, and households moving closer to work and other facilities. Again, these are changes that require time to implement, and therefore the short-term price elasticity for transport fuels is considered to be very low. Nevertheless, although the overall impact of carbon pricing on consumption behaviour is expected to be low in transport and buildings, there are some specific dimensions where it could trigger reductions which are hard to address through other policies. One example is the use and charging behaviour of PHEVs: whereas subsidies and regulations can incentivize the uptake of such vehicles, they are ineffective at steering the charging behaviours of its owners. A carbon price – which would increase transport fuel costs – would be more effective to that effect.

Steering investment decisions: the bulk of reductions in the transport and buildings would thus have to come from investments in energy efficiency improvements and technology switches, and it is here that carbon pricing could have the biggest added value. By providing a long-term signal to investors, a carbon price is expected to steer their decisions towards climate-friendly solutions. In the building sector, whereas the role of a carbon price in triggering building renovations is considered low[18], it is assumed to have the potential to significantly support the uptake of fossil-free heating systems such as heat pumps (. BPIE, 2021, ICF *et al.*, 2021). In the transport sector, empirical evidence has found that an increase in fuel prices supports the uptake of smaller, more efficient vehicles, in particular if the price increase is policy-driven and therefore more structural than market-driven price fluctuations (Leard, 2016). In a similar logic, it could also be expected that carbon pricing will further support the uptake of Zero and Low Emission Vehicles, although other factors (such as CO_2 standards, technology development and charging infrastructure) will also play a role. Of course, investment decisions could also be steered through other policy measures such as subsidies and/or regulations. However, the increasingly ambitious reduction objectives require vast investments, and steering those through subsidies alone would increase pressure on the public budget. A carbon price could support such measures by supporting low-carbon investments through fuel price levels.

Non-market barriers are a real issue for the transport and even more so for the buildings sectors. Primary examples in the building sector are split incentives (the landlord-tenet paradigm), lack of information, non-economic rationale behaviour of building owners, shortage of skilled workers and renovation experts, and the investment challenge for households with limited financial capacities. For the transport sector, non-market barriers exist in the form of system/infrastructure dependency which sometimes prevents/slows uptake of new technologies or behavioural change, such as the lack of charging infrastructure, or of safe infrastructure for softer transport modes. The market signal from a carbon price will do little to overcome these barriers, which means that if emission trading is implemented in isolation, some cost-efficient reduction levers will not be sufficiently triggered and the cap will have to be met through more expensive measures, increasing overall costs.

In conclusion, complementary policies will have to continue to play an important role to achieve ambitious emission reductions in the transport and buildings sectors by 2030. Emission trading alone will not drive such reductions unless at very high prices, due to low short-term price elasticities and prevailing non-market barriers. However, carbon pricing could be implemented in support of such other policies, to align price signals with decarbonization efforts, steer long-term investments, and generate revenues which could be used to facilitate the transition. In the absence of carbon pricing (or other pricing instruments with a similar effect), other reduction

[18] As renovations are not only triggered by monetary incentives but depend on other non-economic factors that vary among different owner structures

policies might be counteracted by market forces, especially in the buildings sector where electrification is discouraged by the price gap between electricity and fossil heating fuels prices.

2) Design options

When deciding to apply emission trading to new sectors at the EU level, a number of policy decisions need to be made. In this chapter, we provide an overview of the main decisions that would need to be made, together with an *ex ante*, qualitative assessment of the advantages and disadvantages and overall points of attention for the different options.

2.1 Extending the existing EU ETS versus developing a separate system

In its 2030 Climate Target Plan, the European Commission identified two main options to apply emission trading to the transport and buildings sector: either expanding the scope of the existing EU ETS, or developing a separate scheme. In its "Fit for -55%" package, it went for the second option, primarily to avoid disturbance of the well-functioning system for stationary installations.

In theory, including all sectors in the existing scheme would give the most cost-efficient outcome, at least from a static efficiency point of view. One uniform system allows sectors with higher marginal abatement costs to reduce less and tap into the cheaper abatement potential in other sectors. Several studies have pointed out to the higher marginal abatement costs of transport. Putting such a sector under the same scheme as e.g. the electricity sector with mature renewable technologies and lower abatement costs, would allow the transport sector to tap into this 'renewable electricity' potential without having to reduce its own emissions. However, from a dynamic efficiency point of view, this delayed action in harder to abate sectors risks to increase overall costs on the longer term, as the needed technological development and behavioural change in these sectors are delayed. This provides an argument for a separate ETS for harder to abate sectors (e.g. transport) with higher carbon prices.

Related to this is the impact on competitiveness. The current EU ETS does not only cover the power sector, but also the energy-intensive industry. A large part of this industry is deemed to be exposed to international competition and consequently the risk of carbon leakage (European Commission, 2019b). It is expected that including transport in the existing EU ETS will increase the carbon price (due to higher marginal abatement costs), to levels which might undermine the competitiveness of our industry and therefore increase the risk of carbon leakage (Cambridge Econometrics, 2020). From this point of view, a separate scheme would also be preferable.

Another potential disadvantage of linking an ETS for transport and buildings with the stationary ETS would be that this could lead to a waterbed effect and increase the overall emission budget. This would occur, if transport or buildings would use allowances from the EU ETS that would otherwise be deleted by the Market Stability Reserve (or MSR). This will of course depend on whether the MSR will still be withdrawing allowances at the moment that transport and buildings would be included in the EU ETS. This in turn depends on how the MSR and the EU ETS is reformed in the coming months/years.

On the other hand, two separate schemes will lead to separate carbon constraints, primarily in the form of different carbon prices. This might lead to a distortion of the level playing field for those sectors which will have entities/installations in both schemes, for example due to the thresholds provided in Annex I of the current ETS Directive. E.g. the current scheme only covers combustion installations with a nominal thermal input above 20MW, which means that installations below this threshold could be included in the separate scheme. This is a particular point of attention for those sectors where installations are commonly close to this threshold, such as food processing, smaller chemical sectors, etc. In the worst case, it could provide an incentive for operators to oversize their combustion installation, which is less efficient.

It can also be expected that a separate scheme would lead to higher overall administrative burdens, although the impact could be limited by recycling much of the existing rules and data processes under the existing EU ETS.

One final point of attention are the implications of electrification: electrification is seen as a major pathway towards deep reductions, both for the transport as for the buildings sector. However, as long as the EU power grid is not fully emissions-free, electrification of these sectors will result in a shift of emissions from these sectors towards the power sector (according to GHG reporting standards, emissions are reported where the GHG is released into the atmosphere). In case all sectors would be included in the existing EU ETS, this wouldn't make a difference: even though the emissions would shift from the transport and the buildings sector to the power sector, they would still remain under the same cap. However, the situation is more complicated in case there would be two different schemes. Under this scenario, the emissions would shift from the separate scheme (for transport and buildings) to the existing EU ETS, but the corresponding emission budget would remain within the separate scheme.

Table 2: assessment of the extension of the existing ETS vs. the creation of a new, separate system

	Expanding the existing ETS	Create a separate ETS
Cost-efficiency	Higher 'static' efficiency – lower costs in short term Lower 'dynamic efficiency' – higher costs in the long term	Lower 'static' efficiency – higher costs in the short term Higher 'dynamic' efficiency – lower costs in longer term
Environmental effectiveness	Risk of a waterbed effect/increase in the total emission budget due to interactions with the MSR	No impact on the overall emission budget/no interaction with the MSR
Competitiveness	Increased competitiveness concerns/carbon leakage risks for industry due to higher carbon prices Optimal level playing field within sectors in the EU	Reduced carbon leakage risk (higher carbon prices, but sectors are generally less carbon- and/or trade-intensive). Potential risk of distorted level playing field Within the EU between installations, incentive for installations to shift from one system to the other
Administrative burden	Limited additional administrative burdens	Potentially higher administrative burden, but can be mitigated by building on existing practices in the EU ETS

2.2 Scope: all non-ETS fuels or excluding transport?

Next, it needs to be decided which sectors would be covered by emission trading. In Germany, the national emission trading system covers all standard fuels which are not yet covered by the

EU ETS.[19] One option would be to apply the same scope under a European approach. This would imply that – in addition to transport and buildings – fuel use in non-ETS industry and in the agricultural sector would be included as well. The first main advantage of this approach is simplicity: it avoids the need to split fuel use between different sectors or entities (except for fuel supplied to installations already covered by the EU ETS). It also avoids the need to split energy use within a specific installation or site (e.g. a non-ETS industrial site with an on-site office building). Finally, it ensures that all energetic emissions are covered by a harmonized carbon price. The main downside is that – as the marginal reduction costs in the transport sector are considered to be much higher than in other sectors – there is a risk that this approach would not sufficiently drive down emissions in the transport sector, causing price increases for the other sectors, with adverse impacts on low-income households and business competitiveness.

Therefore, a second option would be to apply the emission trading system to all non-ETS fuels except transport fuels. Instead, transport emissions could be addressed by a tailor-made approach with incentives which are strong enough to reduce emissions, while avoiding adverse impacts on other sectors. The main downside of this approach is that it could increase complexity and result in "grey area's". Under such an approach, it has to be decided whether fuel use in rolling agricultural equipment has to be considered as 'transport fuels' or not.

Eventually, the Commission is proposing a third option: fuel consumption in road transport and buildings are included, but the system would not cover fuel consumption in other transport sectors (rail and inland waterways), in non-ETS industry and in agriculture. The main argument for excluding non-ETS industry and agriculture is that some operators in these sectors could be exposed to carbon leakage, and the administrative burden of having to design and implement carbon leakage compensation measures was considered disproportionate compared to the expected environmental benefits of their inclusion. However, there are also downsides to this approach. Firstly, there is the element of fairness: it could be considered unfair that most sectors and households – including low-income households – would have to pay a price on GHG emissions, and that just a few sectors get preferential treatment. Secondly, for some industrial sectors with installations both within as outside the existing EU ETS, the existing distortion of the level playing field continues to exist.

[19] With coal and municipal waste burned in non-ETS installations being covered as of 2023.

Table 3: assessment of different scope options

	Cover all non-ETS fuels	Exclude transport fuels	Exclude industry and agriculture
Regulatory complexity	Low complexity, would only require a split between fuel use in existing ETS installations and other fuel use.	Increased complexity, might require site-specific splits	Low complexity, no carbon leakage provisions needed
Environmental effectiveness	Prices might not reach levels required to decarbonize transport	Allows to apply higher prices to transport if required, to ensure dynamic efficiency.	No carbon price signal in the excluded sectors
Competitiveness	Increased competitiveness concerns industry due to higher expected carbon prices.	Allows to 'shield' other sectors from the higher carbon prices which are expected to be required in the transport sector.	Less risk of carbon leakage for non-ETS industry and agriculture, but continued distortion of level playing field for some sectors (ETS vs. non-ETS installations)
Impacts on households	Risk of adverse impacts on low-income households as transport puts upward pressure on carbon price	Possible to 'shield' other sectors from the higher carbon prices required in the transport sector	

2.3 Point of regulation

Once the scope has been decided, a decision has to be made on the point of regulation: which natural or legal entities will be legally responsible for reporting emissions and surrendering allowances. The most straightforward way – which is also used in the Californian cap-and-trade system and the recent German system for transport and buildings – is to regulate at the level of fuel suppliers. The alternative- regulating at the level of end consumers – would lead to very high administrative burdens (as each household would have to report emissions, open a trading account, and purchase and surrender sufficient allowances). As this is deemed unrealistic, we have considered that the approach via fuel suppliers is the only, practically feasible option. This approach is also proposed by the European Commission.

2.4 Maintaining the sectors in the Effort Sharing Regulation?

A fourth important decision is, – if an emission trading system with an absolute cap is implemented for transport and buildings – whether they should still be covered by the Effort Sharing Regulation, which imposes legally binding reduction objectives on each member state.

As described in chapter 1, other policies than carbon pricing will have to continue to play a central role to achieve the ambitious emission reductions by 2030 in the transport and buildings sectors, unless carbon prices are allowed to reach high levels (well beyond €100/t). Currently, the Effort Sharing Regulation provides a strong incentive for member states to implement such policies at the national level. The main question is thus if these other policy instruments would still be taken either at the EU or at the national/local level in absence of the Effort Sharing Regulation.

It can be expected that if transport and buildings would be covered by an emissions trading system, but no longer by the Effort Sharing Regulation, member states will have less incentives to adopt ambitious complementary climate policies at the national level. This is because the 'cost' of such policies (which can be either financial costs or political costs) would be borne by the specific member state, whereas the benefit (lower carbon prices under an emission trading system) would be for the EU as a whole. Without some sort of obligations for member states, they will be less inclined to adopt ambitious but sometimes costly policies to complement a European trading system, which would lead to a higher overall carbon price. This could partially be addressed by additional EU policies, although not in full. Taking into account the subsidiarity principle, some measures are more effective if taken at the national or even the local level, such as for example spatial planning which is a crucial enabling condition to reduce emissions in some sectors, or specific strategies to increase the renovation rate in buildings. Furthermore, without binding national reduction targets, member states might also be less inclined to support ambitious EU climate policies in case these could trigger resistance from the public or specific economic sectors domestically. Therefore, maintaining the Effort Sharing Regulation provides the best guarantee that an emission trading system would be complemented by ambitious national and European reduction policies. Without these policies, a much higher carbon price would be required to achieve the required reductions in the transport and buildings sectors. The main advantage of phasing out the Effort Sharing Regulation is that it avoids politically sensitive and difficult negotiations on how to distribute the required reduction objective in nationally binding objectives. Reaching an agreement on the distribution of the current 30% reduction objective was already a challenging process which took 3 years. The challenge of reaching an agreement on an even higher reduction objective will prove to be even more difficult. A second advantage is that it would result in a more cost-effective distribution of the reduction effort between member states. Until now, national targets under the ESR have been mainly set based on GDP/capita, with a high differentiation between lower- and higher-income member states. This approach is maintained in the Commission's proposal to revise the ESR, with national objectives ranging between -10% and -50% by 2030 compared to 2005. A uniform carbon price (through emission trading) instead of differentiated national objectives would lead to a more cost-effective distribution of efforts between member states, although at the risk of higher overall costs as non-market barriers could less addressed through other flanking measures. Furthermore, combining different policies increases complexity and makes it more difficult to assess the impact of each individual policy instrument, and of emission trading in particular. As a result, it becomes more difficult to identify and address potential shortcomings of specific policies.

Table 4: assessment of whether or not to exclude sectors from the Effort Sharing Regulation

	Exclude sectors from the ESR	Maintain the ESR in place
Cost-efficiency	Risk of higher overall costs, as member states are less incentivized to adopt ambitious complementary policies at the national or the EU level to address non-market barriers. More cost-efficient distribution of efforts between member states, as reductions are mainly triggered by a harmonized carbon price instead of differentiated national targets.	Potentially lower overall costs as member states are more likely to adopt ambitious complementary policies at the national and EU level to address non-market barriers. Less cost-efficient distribution of efforts between member states, if the existing methodology (based on GDP/capita) is continued.
Political feasibility	Avoids difficult negotiations on national reduction objectives	Will lead to difficult negotiations, revision of the current methodology would likely be necessary.
Policy evaluation	Easier to monitor and assess the impact of emission trading on emissions and to adjust the instrument if needed.	Complex interactions between different policy instruments, making policy evaluation more difficult.

2.5 Cap setting methodology

Both the current EU ETS as the national emission budgets under the Effort Sharing Regulation follow a linear reduction trajectory which reduces at the rate required to achieve the envisaged reduction objective by 2030. It is likely that an emission trading system for the buildings and transport sector would follow a similar approach. If this is the case, a decision needs to be made for both the starting point as the end point of the linear cap trajectory.

With regards to the starting point, there are two main options:

1) Apply starting point based on **recent historic emissions** (= current approach under the Effort Sharing Regulation). This could be done based on an average value of a multi-year period to reduce the impact of exceptional emission fluctuations (e.g. due to exogenous shocks such as the COVID-19 crisis in 2020/2021). The main advantage is that it ensures that the cap would not be set too high (leading to the build up of a surplus in the first years) nor too low (requiring unfeasible reductions right from the start). However, the disadvantage is that it would lead to perverse incentives, as it would 'penalize' overachievement of previously agreed objectives, and 'reward' underachievement of previously agreed objectives.

2) A starting point based on **the agreed emission budget under the ESR** (= the approach under the current EU ETS, where the cap for 2021-2030 starts based on the 2020 cap level). The main advantage is that this can be considered a fair approach, where overachievement of previous objectives is rewarded and underachievement is penalized. The disadvantage is that it could lead to a cap that starts far above or below actual emissions, which would result in supply-demand imbalances right from the start. Furthermore, this approach would require a calculation of the share of energy-related CO_2 emissions in the total ESR emission budget.

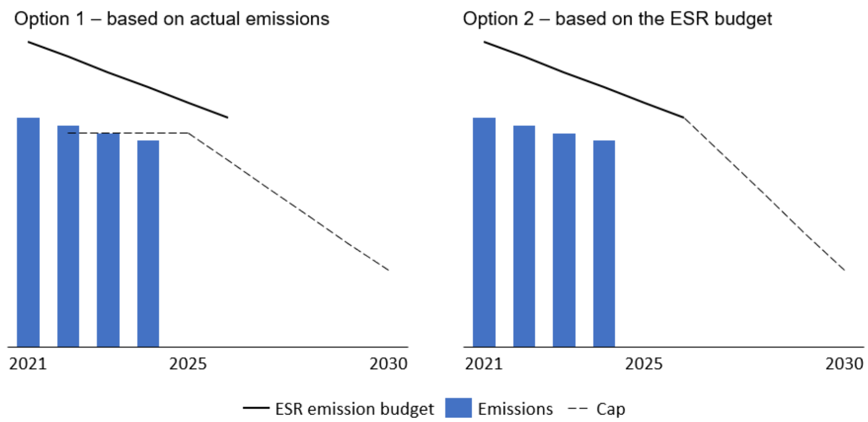


Figure 8 Cap starting point options

Table 5: assessment of cap starting point options

	Starting point based on emissions	Starting point based on the ESR budget
Supply-demand balance	Low risk that the system would start with a significant surplus or deficit from the start	Higher risk that the system would start with a significant surplus or deficit from the start
Fairness	Rewards underachievement, penalizes overachievement	Overachievement of previous objectives is rewarded, underachievement of previous objectives is penalized.

With regard to the end point, the approach that has been used by the Commission in the past was to base the required reduction per sector on the results of the policy scenarios in their Impact Assessments. This has been the approach to split the effort between the EU ETS and the ESR both for 2020 as 2030. **Our main assumption is that this approach would also be used for the upcoming proposals.** This would imply the following required reductions by 2030 (compared to 2005)[20]

[20] Based on the Impact Assessment accompanying the 2030 Climate Target Plan, SWD(2020) 176 final PART 2/2, table 39

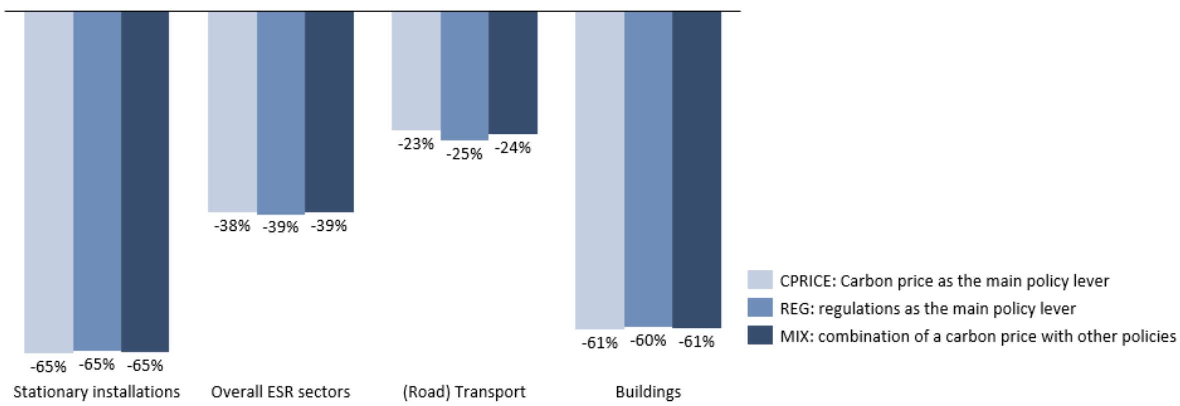


Figure 9: Required reductions by 2030 (compared to 2005) based on the European Commission's policy scenarios

Note that this approach would result in **very ambitious end-point of the cap for buildings in 2030** (+/- 60% below 2005 emissions levels), especially when taking into account reductions already achieved between 2005 and 2019.

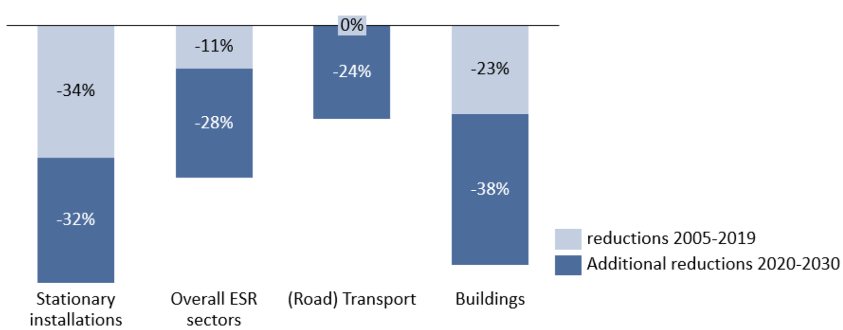


Figure 10: required reduction in 2020-2030, taking into account progress in 2005-2019

Such a stringent cap for buildings could lead to high carbon prices, especially if other policies aimed at increasing renovation rates do not deliver as hoped.

The Commission's proposal follows a combination of the options above. The cap starts based on the emission budget under the ESR, as described above (option 2), and then follows a linear reduction to be 43% below 2005 emission levels by 2030 (based on the Commission's revised policy scenarios). In 2028, the cap is potentially recalibrated based on verified emissions in the transport and buildings sector. Overall, the outcome of the Commission's proposal closely aligns with the cap assumption that has been used for this report[21], as shown in figure 11 below. The start point in 2024 under the Commission's proposal would be slightly lower, and as a result the overall emission budget would be slightly lower than the assumed cap for this report (4405 million EUA's compared to 4473 million EUA's assumed for this report, or a decrease of -1,5%).

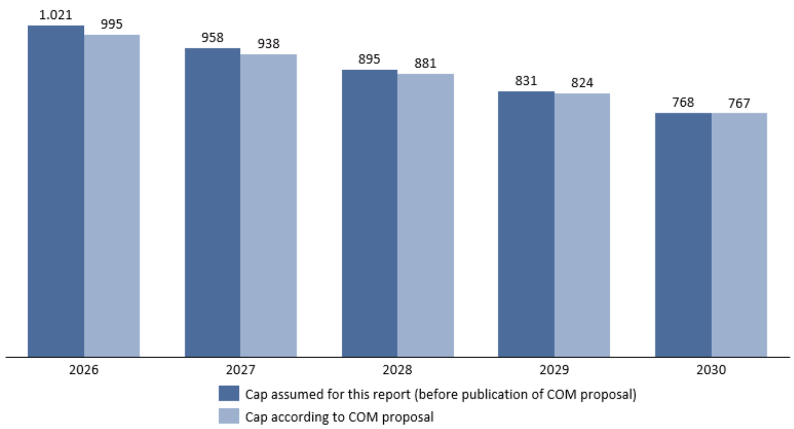


Figure 11: comparison of the cap for the new ETS for buildings and transport (in million allowances)

2.6 Allocation methodology + approaches to address social/competitiveness concerns

Once the cap is set, a decision has to be made on how the allowances under the cap are brought to the market (= the 'allocation' methodology). The default allocation methodology under the existing EU ETS is auctioning, with free allocation as a transitional measure to protect sectors which are deemed to be exposed to carbon leakage (which is measured as a function of trade and carbon intensity).

Most of the energy-related emissions under the non-ETS are emitted in sectors where the risk of carbon leakage is low, as both the trade and/or carbon intensity is low. For example, energy use for the heating of buildings or the transportation of people and goods cannot be replaced

[21] After exclusion of the part of the cap relating to agriculture and non-ETS industry, which would be excluded from the scope.

by imports from outside the EU with less stringent carbon constraints. Therefore, we assume that auctioning will also be the default allocation methodology in an emission trading system for non-ETS sectors.

However, there are still some segments within the non-ETS sectors which policy makers might want to shield – at least partially – from the carbon price, such as vulnerable, low-income households and/or specific sub-sectors in the industry and agriculture sector with a higher exposure to the risk of carbon leakage. To shield these segments, three options could be considered:

- Exclude these segments from the emission trading system: under this approach, fuel suppliers would not need to report emissions nor surrender allowances for fuels which are supplied to these segments. However, this would require fuel suppliers to report each year on how much fuel has been supplied to these segments, which adds to the administrative burden. It would also mean that the scope of the ETS could change from year to year, which is also cumbersome and undermines the predictability and makes it difficult to determine the cap. Finally, it does not guarantee that fuel suppliers would not pass on the carbon cost to these segments, resulting in windfall profits for the fuel suppliers. For these three reasons, this options seems undesirable;
  - Provide free allocation for these segments: the main advantage of this option compared to the previous one is that the scope of the system would remain unchanged, leading to less administrative burden and more predictability. The free allocation could be given either to:
    - The fuel suppliers. However, this would again require them to report each year how much fuel they have supplied to each of these segments. In addition, there is again no guarantee that the fuel supplier will not pass on the carbon cost to the end consumer anyway;
    - The end consumer itself. In this case the end consumer would have to report how much fuel it consumed + it would have to monetize the received allowances somehow to recover its financial value. Although this could be feasible for carbon leakage exposed companies, it would be unrealistic to expect low-income households to do this as well (e.g. they would have to open a registry account to receive the free allocation);
  - The third option would be direct financial compensation for the targeted segments (similar to the current system for indirect carbon leakage compensations). This would have several benefits compared to the previous two options: the scope would remain unchanged, the administrative burden would remain manageable (e.g. no need for

low-income households to open a registry account to hold allowances), and the support would be given directly to the targeted segments, limiting the risk of windfall profits. The details of this option are discussed in the following sub-chapter on revenue recycling. This approach was taken in the German system.

Table 5: assessment of approaches to address social/competitiveness concerns

	Exempt from scope	Free allocation (to fuel supplier)	Free allocation (to end consumer)	Financial compensations
Stability of the system	Scope would change year by year	Scope would remain unchanged		
Administrative complexity	Requires annual reporting by fuel suppliers		Requires regular reporting by end consumer + engaging in allowance transfer	Might require regular reporting from end consumers
Windfall profits	Significant risk, as there is no guarantee that fuel suppliers won't pass through carbon costs		Limited risk, as the compensation is given directly to the end-consumer	

Eventually, the Commission has used the following approach to address social and competitiveness concerns:

- Agriculture and non-ETS industry – which are the two non-ETS sectors most vulnerable for carbon leakage – are excluded from the scope altogether. The Commission argues that complexity of developing a tailor-made approach to identify and shield only the exposed sub-sectors is disproportionate compared to the environmental gain of excluding the sectors as a whole;
- Member states are required to use auctioning revenues for measures addressing decarbonisation challenges in the road transport and buildings sector. In addition, the Commission has specified that about 25% of expected revenues should flow to the Social Climate Fund which will be used to support vulnerable households and companies.

2.7 Definition of main policy scenarios

Based on the different policy options described above, we have identified 4 main policy scenarios, each time with two variants (ESR/no ESR)

- Existing, all fuels: the existing EU ETS is extended to all fuels which are currently covered by the ESR;
- Separate, all fuels: a separate system is created for all fuels which are currently covered by the ESR;
- Existing, excl. trans: the existing EU ETS is extended to all fuels which are currently covered by the ESR, with the exception of fuels which are consumed in the transport sector;
- Separate, all fuels: a separate system is created for all fuels which are currently covered by the ESR, with the exception of fuels which are consumed in the transport sector;

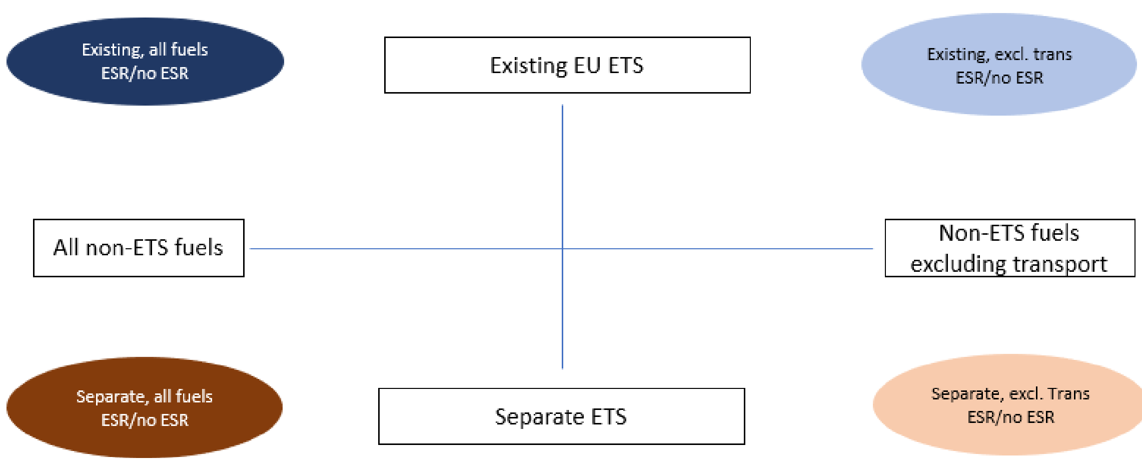


Figure 12: overview of main policy options

Furthermore, the following assumptions have been made across all policy scenarios:

1. Where the existing EU ETS is extended to new sectors, this is done in the same way as has been done for aviation in the past. This means that a separate sub-cap is determined, there is no impact on the distribution of the cap for stationary installations (auctioning share, size of the Modernization and the Innovation Fund), and the new sectors are not taken into account for the functioning of the MSR. However, allowances are fully exchangeable between the different sectors, in both directions;
2. The Linear Reduction Factor (LRF) for the cap of stationary installations is increased as of 2026. The starting point is the cap level for 2025 (no recalibration of the cap based on actual emissions);

3. Emission trading would start to be applied to new sectors as of 2026. The starting point is set based on recent emissions (average of 2021-2023), and then decreases linear towards the required end point in 2030.
4. All allowances for new sectors are auctioned. Auctioning revenues are fully distributed between member states based on shares in most recent, verified emissions (2018)

The proposal of the Commission is most closely aligned with the “Separate, all fuels, ESR” scenario (dark red in Figure 12 above): a separate scheme would be created for both building and transport fuels, and these sectors would continue to be covered by the ESR. Main differences between this scenario and the Commission’s proposal are:

- Whereas the scenario incudes all non-ETS fuels, the Commission proposes to exclude all fuel use in the agricultural and non-ETS industry sectors and in non-road transport(see also point 2.3 above). However, the impact of this change on the different findings of this report are expected to be limited, given that road transport and buildings represent the bulk of the emissions in non-ETS fuel use (91% in 2019);
- For the existing EU ETS, the proposed cap adjustments are more stringent than what has been assumed under this report’s scenarios: the new LRF would already apply as of the year after entry into force of the revision (which could be as soon as 2023) and the starting point of the cap would be lowered. On the other hand, the functioning of the MSR is expected to lead to a lower withdrawal. Therefore, we expect that the results of our ‘existing ETS’ scenarios remain relevant;
- With regard to the distribution of auctioning revenues, there are two minor differences under the Commission’s proposal. Firstly, 150 million allowances would be auctioned by the Innovation Fund instead of member states. However, its impact on assumed member states auctioning volumes is offset by the slightly higher overall cap (see section 2.6 above). Secondly, auctioning volumes are distributed between member states based on average 2016-2018 emissions (instead of 2018 emissions). The impact of this is also considered to be negligible.

3) Impact on the carbon price

a. Methodology

To get an indication of the expected carbon price levels under the different scenarios, we have used the following approach:

- First, we have made an assessment of what emission levels to expect in the different economic sectors (power, industry, transport and buildings) under a carbon price level of €40, €70 and €100 per ton in 2030. For transport and buildings, we have also differentiated between whether the sectors would still be included in the ESR or not.

- Secondly, we developed a simulation tool which allows to model the allowance supply-demand balance of the EU ETS (and a potential separate system), in function of a number of different policies and assumed emission levels. The tool allows to simulate the functioning of the system in line with each of the 4 policy scenarios described above, taking into account the different complexities of the system (such as the functioning of the MSR, changes in supply due to one-off flexibility with the ESR, the functioning of the Modernization Fund, etc. …).

- We then used a reiterative approach to see what carbon prices would be feasible under the different policy scenarios. For this, we first set the parameters in the simulation tool to match the relevant policy scenario. We then ran the model with the €40/ton emission scenarios as an input, after which the model calculated the supply-demand balance up to 2031. If the model reached a very low surplus (which is expected to lead to a price increase, as some surplus is needed to ensure liquidity and hedging) or even a deficit in 2031, we reiterated the exercise with the €70/t emission scenario as input. If needed, a third iteration was done with a €100/t emission scenario.

This approach allows us to identify a range in which the carbon price could end up under the different policy scenarios (with the lower bound set by the carbon price level which leads to a deficit on the market, and the upper bound set by the carbon price level which still allows for a limited surplus in the market until 2031). If – even with the €100/t emission scenario as an input – the policy scenario would still lead to a deficit in the market, we conclude that prices would go beyond €100/t without further analysing how much more they would increase.

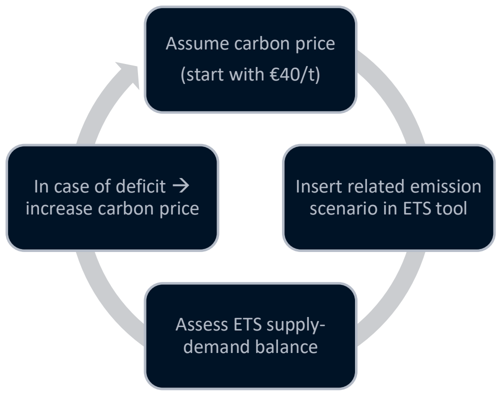


Figure 13: methodology to assess potential carbon price levels

Note that our approach does not take into account other parameters that might impact carbon price levels, such as technological breakthroughs, energy price developments, speculative buying by investors, and the degree to which the market anticipates further developments after 2030.

b. Resulting carbon price projections

Based on the methodology described above, we see that price levels could vary significantly depending on the policy scenario taken. Overall, the following trends can be observed.

A separate system will lead to higher prices compared to the extension of the existing EU ETS. There are three main reasons for this:

1) When extending the existing system, the transport and buildings sector would have access to the surplus that is expected to persist to some extent in the EU ETS between now and 2030;
2) In general, marginal reduction costs in stationary installations are also considered to be lower compared to the buildings and transport sector;
3) Finally, we have assumed that the (sub)cap for buildings would be based on the European Commission's policy scenarios, which would result in a very stringent cap (see chapter 2.6 for more details). Without access to reduction potential in other sectors, a

high carbon price would be required to achieve the required reductions within the buildings sector.

Excluding covered sectors from the ESR will lead to higher carbon prices. This is because we have assumed that without the ESR, member states will have less incentives to adopt ambitious complementary policies both at the national as at the European level. As explained in chapter 1, such complementary policies are crucial to leverage some of the levers that are insufficiently triggered by a price signal alone, e.g. due to market failures. Without the ESR, these levers would remain underused, and a higher carbon price would be required to achieve the same levels of reduction.

In or excluding transport from the scope does not seem to have a big impact on the carbon price. This is because the subcap for transport – if based on the Commission's modelled policy scenarios –would require only 24% reductions by 2030, which is relatively little when compared to the required reductions in e.g. buildings. Furthermore, it is expected that reductions in the transport sector will be supported by ambitious CO_2 norms, an increased availability of affordable zero-emission vehicles in the coming years (BloombergNEF, 2021), and a relatively high turnover rate of passenger vehicles, making it easier to stay within the cap.

This means that the highest prices can be expected when non-ETS fuels are put in a separate system and are no longer covered by the ESR. This would result in prices beyond €100/t. This finding is consistent with recent modeling by Cambridge Econometrics, where a similar policy scenario would result in a carbon price of €180/t $CO_{2eq.}$ by 2030 (Cambridge Econometrics, 2021). Main cause of such high prices are the low short-term price elasticities in the transport and buildings sectors, caused by non-market barriers and long investment cycles (see chapter 1). On the other hand, lowest prices could be expected when non-ETS fuels are included in the existing EU ETS and remain covered by the ESR at the same time. Nevertheless, even under this scenario, prices are expected to remain within the €40 to €70/t range.

Under all other policy scenarios – including the scenario which most closely aligns with the Commission proposal – carbon prices are expected to reach between €70 and €100/t by 2030. This is in the same order of magnitude as the modelled carbon price under the Commission's MIX-CP scenario. In this scenario – which assumes a limited increase in complementary policies – the carbon price would reach €80 by 2030. Under the Commission's MIX scenario – which assumes a medium intensity increase in complementary policies – the carbon price would however be lower, and reach €48 by 2030.

Table 6: 2030 carbon price ranges in 2030 under the different policy scenarios

Existing ETS or separate scheme?	Maintain ESR?	Excluding transport from scope?	Price range [in €/t $CO_{2eq.}$]
Existing	Yes	No	€40 to €70
		Yes	
	No	No	€70 to €100
		Yes	
Separate	Yes	No	
		Yes	
	No	No	> €100
		Yes	

4) Impact on Flemish transport and buildings emissions

a. Overall Methodology

To assess the impact on the Flemish transport and buildings emissions, we have developed the following emissions scenarios

- A Baseline + EU measures scenario: this scenario is based on currently implemented policies and takes into account the additional impact of ambitious EU measures that are expected to be implemented in context of the Fit for 55 package;
- 6 scenarios that start from the Baseline + EU measures scenario, and take into account the additional impact of a carbon price signal of respectively €40, €70 and €100/t in 2030, and the inclusion or exclusion of the transport and buildings sectors in the Effort Sharing Regulation.

To develop these scenarios, we have used the 'BE Pathways Explorer'[22] that has recently been developed for the Belgian federal environment administration. This is a simulation tool that allows to model emission scenarios in function of a number of assumptions to be made by the user on a number of emission drivers or 'levers'. This model has been developed for the Belgian level, covering all three Belgian regions. We have assumed that modelled emission trends at the Belgian level would also apply to the Flemish level. Given the relatively similar profile of the Flemish, Walloon and (to the lesser extent) Brussels' buildings and transport sector, we consider this simplification justifiable. Furthermore, some specific adjustments were made in context of this study to have the model match closer to the Flemish specific circumstances.

It should be noted that the outcome of our methodology highly depends on the assumptions made with regard to the impact of a carbon price level and/or the Effort Sharing Regulation on the different emission levers in our model. Within the scope of this project, it was not possible to do an in-depth analysis of the impact of carbon prices or specific other policy measures on the different emission levers. Instead, we have made some overall, high-level assumptions

[22] See becalc.netzero2050.be

taking into account our best understanding. Where available, we have based our assumptions on existing studies, scenarios and scientific literature. However, in some cases such information was not available, and an own estimation had to be made. In any case, the results from our emission scenarios aim to identify overall trends and orders of magnitude and should not be considered as a detailed impact assessment of specific policy instruments.

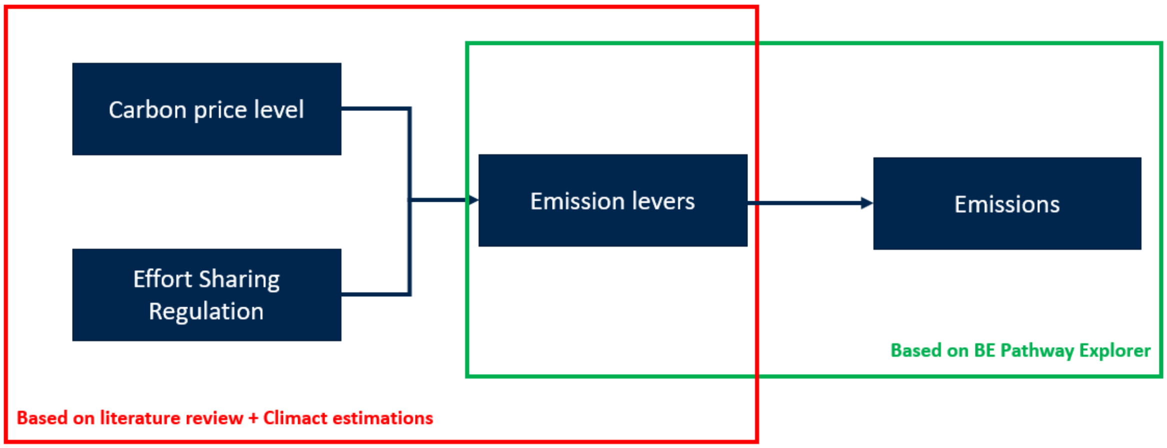


Figure 14: overall approach for emission scenario modeling

The most important underlying assumptions for our emission scenarios are described in sections b) (for the transport sector) and c) (for the buildings sector) below. A detailed overview is provided in Annex.

b. Main assumptions for the transport sector

For our emissions scenarios, we have identified 4 main levers that have an impact on transport emissions: the overall transport demand, the respective modal shares (e.g. % of cars vs. rail vs. active transport), vehicle efficiency and the shares of Zero and Low Emission Vehicles (ZLEV's) in new sales. Other factors that might impact emissions – such as population growth or the blending of biofuels and other Low Carbon Fuels in the energy mix have been assumed to remain constant over all scenarios.

Overall findings from other studies

We have found several studies that assess the impact of a carbon price on transport emissions. Most of them base their analysis on an ex post analysis of historic price elasticities: to what extent has transport fuel demand responded to historic price evolutions. The overall conclusions of these studies is that short-term price elasticity in the transport sector is very low, and therefore short-term demand for transport fuels only decreases marginally in function of a carbon price (Federal Planning Bureau, 2019) (Cambridge Econometrics, 2020) (Alberini, 2021) (PWC, 2019). An additional argument for this hypothesis is that the implicit carbon price via excise duties and VAT is already quite high (around €360/tonne of $CO_{2eq.}$), and therefore an additional carbon price increase of up to €100/t won't have a big impact.

However, there are also counterarguments to be found for this conclusion. Several other studies have found that whereas price elasticities in response to market-driven price fluctuations is low, it could be much higher when the price increase is caused by structural policies rather than short-term market fluctuations (Leard, 2016). One study even found that price elasticity can be up to three times higher if the price increase is caused by a structural policy measure (in case of this study, the Swedish carbon tax) instead of market factors (Andersson, 2019). This is because in the latter case, actors expect the price increase to be sustained in the future, and are therefore more willing to adapt their mobility behaviour. Furthermore, price elasticities also increase in the longer term, as actors take it into account when making investment decisions (e.g. where to live, what type of vehicle to buy, …) (ICF *et al.*, 2021, VTPI, 2013). For example, several studies have pointed out a strong correlation between price increases and improved fuel efficiency of vehicles (Leard, 2016). With the expected increase in the availability of affordable, zero-emissions vehicles with longer driving ranges (BloombergNEF, 2021), it could also be expected that a (fossil) fuel price increase might trigger or at least support the uptake of ZLEV's by the market. Previous analysis by Climact has shown that – whereas compact electric vehicles already have cost-parity with their fossil alternatives today, when taking into account the Total Cost of Ownership – a carbon price could decrease the cost parity time with 1/3 (Climact et al., 2018). Therefore, it can be assumed that a carbon price would support the market uptake of ZLEV's, provided that the appropriate infrastructure to accommodate such vehicles (e.g. charing infrastructure) is in place.

Based on the different elements and findings described above, we have used the following assumptions for developing our transport emission scenarios:

Assumptions with regard to transport demand and modal shares

Under the baseline scenario, we've assumed that a stable transport demand per capita in combination with an increasing population leads to an overall increase in passenger transport demand. Similarly, a growing economy leads to an increased freight transport demand.

Furthermore, we have assumed a stable modal split for passenger transport, and a very limited shift from Heavy Duty Vehicles to rail and waterways in the freight sector.

We have assumed that the impact of a carbon price (through emission trading) on transport demand and the modal split is very limited by 2030 (based on the analysis of the Federal Planning Bureau, see (Federal Planning Bureau, 2019), as short-term price elasticity is generally considered to be very low, and we would not expect emission trading for transport to be implemented before 2026. As highlighted in several studies (ICF *et al.*, 2021, VTPI, 2013) the impact might increase over time as the carbon price might increase further, and people and companies adjust their behaviour in realization that fuel price increases are structural. However, as the system would only start in 2026, we did not assume these long-term impacts would materialize by 2030.

On the other hand, transport demand and modal shares can be more effectively addressed in the short-term through other policy instruments (such as e.g. investments in public transport, infrastructure for alternative transport modes, road pricing, etc. …). Therefore, we have assumed that if transport remains included in the Effort Sharing Regulation, this would have a more significant impact on both overall transport demand (-5% compared to the baseline for both passenger as freight) as well as the modal split (-3% share of passenger cars)[23].

Assumptions with regard to vehicle efficiency and share of LEV's/ZEV's in new sales

Under the baseline scenario, we assumed a modest improvement in the efficiency of new sold vehicles, both for passenger (+6%) as for freight vehicles (+3%). The share of Low and Zero Emission Vehicles would also remain low, at 8% for passenger cars and LDV's. Under the baseline + EU measures scenario, this share increases significantly due to an expected ambition increase in the CO_2 standards for vehicles. As a result, almost 50% of new passenger cars and LDV's and 20% of HDV's sold in 2030 would be either Low or Zero-emissions. Nevertheless, traditional internal combustion engine vehicles (or ICE vehicles) would still remain an important market share in new sales by 2030.

[23] This is still a modest impact for passenger transport compared to the "With Additional Measures" or WAM scenario of the Flemish Energy and Climate Plan. Under that scenario, passenger car vkm's would decrease with -19% by 2030 compared to the WEM scenario.

We have assumed that a carbon price of €40/t would do very little to impact the efficiency and shares of LEV's and ZEV's in new sold vehicles but that the impact would be more outspoken at €70 and €100/t, both for passenger and freight transport (see Annex 4 for full details).

The characteristics of new sold vehicles can also be steered through other policy instruments. Therefore, we have also assumed a significant positive impact of (continued) inclusion of transport under the ESR on the efficiency and shares of ZEV's and LEV's in new sold vehicles by 2030.

It should be noted that the impact of new sold vehicles on 2030 emissions is still relatively limited, as each year only 6,5% of the vehicle stock is replaced. The impact of an increased share of ZEV's and LEV's is expected to increase after 2030 as the vehicle stock is being replaced.

Overview of assumptions

The table below summarizes the main underlying assumptions/logic underpinning our emission scenarios for the transport sector. A detailed overview is provided in Annex 4.

Table 7: general overview of emission scenario assumptions for the transport sector

	Transport demand and modal shares	Vehicle efficiency and ZEV/LEV shares
Baseline	Increased demand Limited shift from HDV to rail/IWW in freight	Very limited efficiency improvements Continued low % of ZEVs/LEVs in new sales
Impact of EU measures	No impact	Significant impact
Impact of a carbon price	Very low impact	Significant impact as of €70/t
Impact of the ESR	Moderate impact	Significant impact

c. Main assumptions for the buildings sector

For our modeling, we have considered 4 main levers that have an impact on building emissions: the renovation rate (% of the building stock that is renovated each year), the renovation depth (%

of reduced energy demand after the renovation of a building), the demolition rate (% of the building stock that is demolished and potentially rebuild each year) and the % of heating demand that is supplied through non-fossil sources (such as heat pumps or biomass). Other factors that might impact emissions – such as population growth, the average housing size per capita, or the energy efficiency standards for new buildings, have been assumed to remain constant over all scenarios.

Overall findings from other studies

Similar to the transport sector, several studies and reports have concluded that a carbon price signal alone would not be sufficient to reduce greenhouse gas emissions in the buildings sector in the short term, due to overall short-term low price elasticities (Cambridge Econometrics, 2020; Regulatory Assistance Project, 2021; PWC, 2019). In particular, fuel price increases (for example due to a carbon price) would not be effective at increasing the renovation rate, due to overall price inelasticities and non-market barriers (e.g. split incentives and/or lack of access to finance for upfront investments). Even with a carbon price of €150/t, fuel prices would not increase sufficiently to trigger energetic renovations (BPIE, 2021). This is especially the case for multi-family dwellings (appartements) or dwellings that are occupied by tenants. For this reason, other policy types such as renovation obligations are considered to be far more effective (Nauleau, 2014). This is also consistent with the Commission's 2030 Impact Assessment, where energetic renovations of buildings are only triggered very modestly by the carbon price under the CPRICE scenario, and are more effectively addressed by regulations under the REG scenario (European Commission, 2020b)

However, in the longer term the price elasticity increases considerably. For example, whereas a carbon price of €25/t would only reduce natural gas consumption with -0,4% in the short term, the reductions would increase sixfold to -2,4% in the long term, when taking into account observed short-term and long-term price elasticities (Regulatory Assistance Project, 2021). This is because whereas a carbon price is not expected to trigger additional investment decisions[24], it is expected to steer investments once they are made anyway. In other words, a carbon price might not be enough to convince building owners to start a renovation. But once they have decided to renovate anyway (e.g. through other policies or because of natural renovation cycle

[24] Unless the price level would become very high.

in a buildings' lifetime), a strong enough carbon price would be able to convince them to go a step further in improving the efficiency of a building or in decarbonizing the energy mix. This is because a carbon price increases the profitability of specific low-carbon investments, both with regards to the thermal insulation of the buildings envelope as the fuel mix (Climact et al., 2018). In particular, carbon pricing is considered as a particularly effective tool in supporting the market uptake of electrified heating solutions such as heat pumps. Currently, the uptake of heat pumps is hindered by a significant price gap between fossil fuels and electricity, in part because taxes and other levies on fossil heating fuels are very low and those on electricity are very high. A carbon price through an emission trading system could effectively address the price gap, therefore increasing the competitiveness of heat pumps compared to fossil heating systems. The effect could be amplified further if the revenues from the carbon price are used to reduce the cost of electricity (BPIE, 2021). The required price level to encourage this switch depends on overall energy prices, potential further decreases in heat pump investment costs, and whether or not revenues from the carbon price are recycled to further lower electricity prices. Previous analysis from Climact has found that a carbon price of €100/t would make an investment in a heat pump economically profitable since it brings cost-parity time between heat pumps and gas-fired boilers to 18 to 20 years, and to 13 and 15 years compared to oil-fired boilers (Climact et al., 2018). In its Impact Assessment accompanying the 2030 Climate Target Plan, the Commission is more optimistic, and a carbon price of €60 would already deliver a significant switch from fossil heating fuels to electricity and other forms of renewable energy (European Commission, 2020b).

Based on the different elements and findings described above, we have used the following assumptions for developing our buildings emission scenarios:

Assumptions on the renovation and demolition rate

Under the baseline scenario, the renovation and demolition rate remain at current levels until 2030. We have considered that new initiatives under the EU Renovation Wave strategy – which focuses specifically on the worst performing buildings - will impact the renovation depth (= the achieved efficiency improvements after renovation) rather than the renovation rate itself. Therefore, the renovation and demolition rates do not increase under our baseline + EU measures scenario.

In line with the findings in other studies, we have assumed that a carbon price of up to €100/t does not have a direct impact on the renovation or demolition rate.

Other policy measures such as regulations and direct support are considered to be more effective at increasing the renovation and demolition rate. Therefore, we have assumed that if the buildings sector continues to be included under the Effort Sharing Regulation, the renovation doubles and the demolition rate increases significantly, to levels which are consistent with the Flemish Long Term Renovation Strategy (Flemish Government, 2020).

Assumptions on the renovation depth

The renovation depth refers to the resulting reduction in energy need after renovation. Our modeling tool makes a distinction between 'shallow' renovations (-15% heat demand per m^2), medium renovations (-43% heat demand per m^2) and 'deep' renovations (-78% heat demand per m^2). Once the total amount of renovations has been determined (through the renovation rate lever), the user can determine how much of these are shallow, medium or deep respectively.

Under the baseline scenario, the historic shares are maintained, with the bulk of renovations being shallow (80%), with a small share of medium (15%) and deep (5%) renovations (IPSOS & Navigant, 2019). Under the baseline + EU measures scenario, we have assumed an important shift from shallow (60%) to medium (32,5%) and to a lesser extent deep (7,5%) renovations, due to the minimum energy performance standards for existing buildings which are planned to be implemented under the Renovation Wave Strategy.

With regards to the carbon price, we have assumed that prices of €40 to €70/t would not have an impact on the renovation depth. However, under the €100/t scenarios, we have assumed that this would create enough incentive for building owners to take their renovation a step further. As a result, the shares of medium and deep renovations would increase further at the expense of shallow renovations.

Finally, we have considered that other policy measures triggered by the Effort Sharing Regulation could not only be effective in increasing the renovation rate, but also the renovation depth. Examples of potential policies are ambitious mandatory standards for existing or renovated buildings, direct financial support, and sharing of information, best practices, … Therefore, we have assumed that in case of continuation of the Effort Sharing Regulation, the renovation depth would increase significantly in line with the ambitions of the Flemish Long Term Renovation Strategy, resulting in a large shift from shallow (-60%) to medium (+50%) and deep (+10%) renovations.

Shares of fossil-free heating system

Under the baseline scenario, we would assume that the historic trend continues, meaning that about 25% of new built residential buildings (33% for tertiary) and 5% of renovated residential buildings (25% for tertiary) switch from a fossil-based to a fossil-free heating system. Other buildings (existing, non-renovated) are assumed to maintain their current energy mix

In context of the Fit for -55% package, the European Commission is considering to include legal obligations in the Renewable Energy Directive with regard to i.a. the uptake of renewable energy in the heating and cooling sector[25]. Although the content of their actual proposal is still unclear, we have therefore assumed that this would lead to legally binding renewable energy requirements for new built buildings, both for residential as for tertiary buildings under the baseline + EU measures scenario.

Furthermore, we have assumed that a carbon price would increase the uptake of fossil-free heating systems, in new and renovated buildings. The impact depends on the price level: we have assumed no impact at €40/t, a moderate impact at €70/t and a more significant impact at €100/t. Under all cases, we have assumed that the carbon price would only be implemented as of 2026, meaning that it only impacts buildings that are built or renovated as of 2026 onwards.

Finally, the uptake of non-fossil heating systems can also be triggered by other policy instruments, such as regulations or direct investment support. In particular for new buildings, strong regulations can have the potential to increase the share of non-fossil heating systems in the near future. Therefore, we have assumed that a continuation of the Effort Sharing Regulation could result in very high shares of non-fossil heating in new buildings already as soon as 2023. For existing, renovated buildings, we have assumed a more modest impact of the Effort Sharing Regulation, and only as of 2026.

[25] The current Renewable Energy Directive already oblige member states to 'endeavor' to increase the share of renewables in the heating and cooling sector with on average 1.3 percentage points per year. However, as this is an effort-based and not a result-based requirement, we have not assumed that this objective would be met under the baseline + EU measures scenario.

Overview of the main assumptions

The table below summarizes the main underlying assumptions/logic underpinning our emission scenarios for the buildings sector. A detailed overview is provided in Annex 4.

Table 8: general overview of emission scenario assumptions for the buildings sector

	Renovation and demolition rate	Renovation depth	% of fossil free heating systems
Baseline	Maintain current shares	Maintain current shares	Stable shares in new-built and renovated buildings.
Impact of EU measures	No impact	Moderate impact	Significant impact, but only on new buildings
Impact of a carbon price	No impact	Limited impact (only at €100/t)	Moderate impact at €70/t, larger impact as of €100/t
Impact of the ESR	Significant impact	Significant impact	Significant impact on new buildings, moderate impact on renovated buildings.

d. Emission results

Transport sector

The modelled emission trends between 2005 and 2030 for the transport sector are shown in **Figure 15** below:

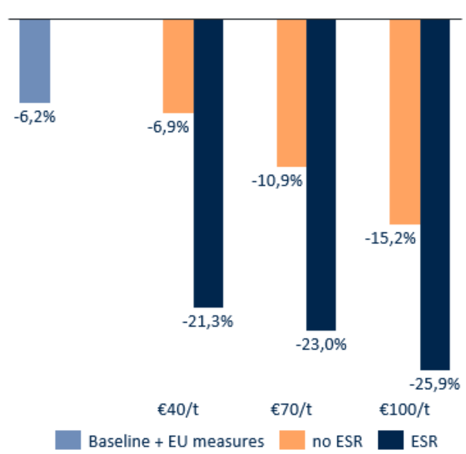


Figure 15: emission reductions in the transport sector (2030 compared to 2005)

In 2019, Flemish transport emissions were at the same level as in 2005 (Flemish Government, 2021). Under the Baseline + EU measures scenario, emissions would start to reduce in coming years, to reach a -6,2% by 2030 compared to 2005. This decrease is mainly caused by the uptake of ZLEV's in the passenger transport sector following ambitious EU CO_2 standards.

Under the 'no ESR' scenarios (where transport would no longer be covered by the Effort Sharing Regulation), we see that a carbon price of €40/t has very little impact, due to a very minor decrease of the transport demand. The reductions become stronger under €70 and especially under €100/t, primarily because of a higher share of ZLEV's in the passenger vehicle stock. Nevertheless, even with a €100/t carbon price, emissions reductions would not approach the levels necessary in context of the overall -55% reduction objective. This confirms the finding that carbon pricing alone will not suffice to drive the required reductions in the transport sector.

Under the 'ESR' scenarios, reductions are more outspoken, due to a combination of a modest decrease of (motorized) transport demand and a further uptake of ZLEV's beyond what's already included under the 'Baseline + EU measures scenario'. Nevertheless, even with additional ambitious policies driven by the Effort Sharing Regulation, a carbon price can still support further reductions by convincing more users to switch from traditional ICE vehicles to ZLEV's, and to opt for more efficient (e.g. smaller) cars. Whereas under the €40/t-ESR scenario emission reductions reach -21,3% by 2030, this would be increased to -25,9% under the €100/t-ESR scenario. This is in line with the EU-wide reductions that would be required under the Commission's policy scenarios to achieve the overall -55% reduction objective.

Buildings sector

The modelled emission evolution from 2005 to 2030 for the buildings sector are shown in **Figure 16** below:

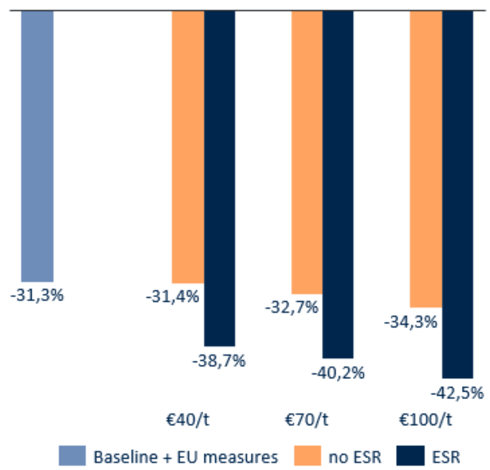


Figure 16: emission reductions in the building sector (2030 compared to 2005)

In 2019, building emissions were already -21,7% below 2005 levels. Under the 'Baseline + EU measures' scenario, the reduction trend would continue and even accelerate, due to more stringent requirements regarding the uptake of renewable energy in new buildings. By 2030, emissions would be 31,3% below 2005 levels.

Under the 'no ESR' scenarios, we see that the carbon price only has a very limited impact compared to baseline + EU measures, confirming that also for the buildings sector, a carbon price alone will not be sufficient to trigger the required reductions. There are several reasons for this:

- As previously described, we have assumed that a carbon price – even at €100/t – would not trigger additional renovations, which is one of the most important levers to achieve emission reductions;
- Secondly, although a carbon price would trigger an increased uptake of non-fossil heating systems, for most buildings this would only be possible after a thorough energetic renovation. For example, heat pumps generate low-temperature heat which is only suitable for buildings that are already energy efficient. Therefore – even if a carbon price increases the uptake of non-fossil energy sources in new and renovated buildings – the overall impact is small as long as the renovation rate is not increased. This is in particular the case because we have assumed that the carbon price would not be implemented (and have an impact) before 2026, meaning it would only work for 5 years

until 2026. Without an increase in the renovation rate, only +- 6% of the building stock would be renovated in that time span.

We see stronger emission reductions under the ‘ESR’ scenarios, as under these scenarios all four levers (renovation rate, demolition rate, renovation depth and fuel switch) would be activated. Due to complementary policies triggered by the Effort Sharing Regulation (translating into increased renovation rate, demolition rate and renovation depth), emissions would be reduced by an additional 7,3 percentage points under the €40/t scenario. Also, it is interesting to note that this gap between the ‘ESR’ and ‘no ESR’ variant increases 7,3% under the €40/t scenario to 8,2% under the €100/t scenario. This is because of **the positive interaction between a strong carbon price and other, complementary policies**: complementary policies can be effective at increasing the renovation rate and renovation depth. As a result, more buildings will reach the efficiency level required to make it suitable for low-carbon heating solutions such as heat pumps. A strong carbon price could then incentivize building owners to also switch to fossil-free heating systems when the building is renovated[26]. It should be noted though that such a positive interaction can only happen if building owners have sufficient access to finance to afford the energy efficiency improvements and a fossil-free heating system at the same time. This might require additional measures, such as low-rate or rate-free loans and/or direct investment support, in particular for lower-income households.

Overall, the impact of a carbon price by 2030 remains limited, even under the €100/t-ESR scenario, in part due to the fact that the emissions trading system would only start in 2026, and the carbon price impact would materialize over the longer term (see chapter 2).

[26] Other policies could also be used to trigger such a switch, but without a carbon price they would have to overcome the prevailing market signals as fossil heating fuels are currently far less expensive compared to e.g. electricity).

5) Impact on Flemish households and companies

The implementation of an emission trading system for the transport and buildings sector will lead to a carbon price, which will in turn impact the energy bills of Flemish households and companies. On the other hand, it will also generate revenues, which can be used to mitigate any undesired impact on the affected actors. In this chapter, we will assess the potential impact as well as the expected auctioning revenues which can (and according to the Commission proposal, will have to be) used to support further reductions and mitigate any undesired impacts.

a. Methodology

Overall approach and assumptions

To assess the impact of emission trading, we have focussed on how the resulting carbon price would affect the energy bills of Flemish households and companies. In doing this, we have made the following assumptions:

1 Costs are passed through perfectly to the end consumer. This means that each consumer – regardless of its size or energy supplier – pays exactly 100% of the implicit carbon cost of the fuels it consumes;
2 Furthermore, we have assumed that other existing taxes and levies remain unchanged. For households, a Value Added Tax of 21% is applied on the embedded carbon price;
3 Current energy prices are based on Eurostat data for 2018[27] for electricity and natural gas, and on the average maximum prices for transport fuels in 2018 as set by the Federal ministry of Economy. We did not take into account any inflation or other energy price evolutions.

We have assessed the potential impact based on a carbon price of €40, €70 and €100 per ton of $CO_{2eq.}$, in line with the emissions scenarios described above. Because some policy scenarios

[27] The nrg_pc_202 to nrg_pc_205 datasets.

would lead to carbon prices above €100/t, we have also extended the analysis under this chapter to a €200/t carbon price.

Assessment for households: per archetype and per income quartile

For households, we have assessed the impact from two different points of view.

On one hand, we have defined a number of fictive households with specific characteristics with regard to size, transport demand and mode, heating demand and heating mix and other electricity consumption (= 'household archetypes'). For this, we started from the archetypes defined by PWC in their study for the Flemish Department of Environment (PWC, 2019), and made some further modifications and additions. Overall, we have assessed the impact for the following household archetypes:

Table 9 overview of household archetypes assessed

Archetype	Transport demand (vkm/year)	Heating demand (kWh heat/year)	Other electricity[1] (kWh electricity/year)
Single, small consumer	/	4500 (natural gas)	1200
Couple, small consumer	8000 (small gasoline)	7000 (natural gas)	2000
Family in old house, no car	/	27500 (fuel oil)	3500
Family in old house, with car	10000 (diesel)	27500 KWh (fuel oil)	3500
Average family[2]	15000 (small gasoline)	23260 (natural gas)	3500
Energy guzzler	25000 (large gasoline)	40000 (natural gas)	7500
Frontrunner	15000 (small electric)	17000 (efficient heat pump)	3500

[1] excluding electricity for transport and heat production
[2] based on consumption types according to the VREG, see https://www.vreg.be/nl/energieverbruik
Consumptions for the other archetype were based on https://www.socialenergie.be/nl/verbruik/referentieverbruik/vergelijken-met-een-referentieverbruik/

On the other hand, we have assessed the average expected impact of a carbon price per income quartile. For this, we have divided the average expenditures per energy carrier for each income category in 2018 by the price for that carrier in 2018, to derive average consumption levels per income quartile and energy carrier. Average expenditures were taken from the Household Budget Survey, available at the website of Statbel.

Assessment for companies: per archetype

Several types of companies would be covered under the Commission's proposal, from family-run small businesses over large, multinational service companies, to companies active in the transport and logistics sector. Because of the heterogeneity, it isn't possible to make any sensible analyses of the impact on an 'average' company. Therefore, we have assessed the expected impact on a number of 'archetypes' of relevant companies, as described below:

Table 10 overview of company archetypes assessed

Archetype	Transport demand (vkm/year)	Natural gas use (MWh heat/year)	Electricity use (MWh electricity/year)
SME – service	280 000 (car)[1]	65[3]	38[3]
SME – bakery	28 000 (car)[1]	80[4]	50[4]
Large logistics company	280 000 (car)[1] 20 360 000 (HDV)[2]	65[5]	38[5]

[1] assumed each employee with a company car drives 28 000 vkm/year, see https://www.fleet.be/2017-reed-gemiddelde-salariswagen-bedrijfswagen-kilometer-afstand
[2] assumed 300 HDV's which each drive 67.876 vkm's per year, see https://mobilit.belgium.be/sites/default/files/kilometers_2016_nl.pdf
[3] assumed 30 employees, using an office space of 330 m^2, see https://www.energievergelijken.nl/zakelijke-energie/energieverbruik-kantoor#
[4] see https://www.bakkerswereld.nl/nieuws/nieuws/2018/06/bakkers-gaan-meer-betalen-voor-energieverbruik-10148965
[5] assumed similar as SME service for the administrative personnel

Methodology for calculating the auctioning revenues

The projected auctioning revenues are determined by multiplying the auctioning volumes for Flanders with the projected carbon price.

The auctioning volumes are based on the Commission's proposal. It takes into account the following elements and assumptions:

- the expected cap will be set as described in section 2.3
- 150 million allowances will be auctioned by the NER
- 600 million allowances from the cap will be 'frontloaded' from 2028-2030 to 2026

- The Social Climate Fund will be financed through the auctioning revenues. We've assumed that in 2026-2028, every year €7,9 billion in auctioning revenues will be put in the Social Climate Fund. This increases to € 16,2 billion annually in 2029-2031
- The Flemish auctioning share is based on the average share of its 2016-2018 road transport and buildings emissions in total EU27 road transport and buildings emissions, which is the same approach as proposed by the Commission for member states. As a result, the Flemish share is set at 2,3%
- Within the auctioning volumes we have also made a split between volumes relating to households (residential buildings and passenger transport) and companies (tertiary buildings, freight transport), based on their respective shares in 2016-2018 emissions.
- Based on the proposal for the Social Climate Fund, Belgium could receive up to 2,56% of the means in the Fund. The Flemish share within this Belgian share is assumed to be based on the share of Flanders in the 2016-2018 Belgian road transport and buildings emissions, resulting in a 59% share.

Regarding carbon prices we have used 3 different price trajectories:

- Under the €40/t trajectory, prices are expected to be at €40/t throughout the entire period 2026-2030;
- Under the €70/t trajectory, prices are expected to start at €40/t in 2026 (still relatively low, due to frontloading), and then increase linearly towards €70/t by 2030.
- Under the €100/t trajectory prices are expected to start at €70/t in 2026, and then increase linearly towards €100/t by 2030.

b. Impact on households

Impact based on household archetypes (before revenue recycling)

Before applying emission trading, the different household archetypes would spend between €500 and €7500 per year on their energy bills, depending on their consumption profile. The bulk of this would be related to heating fuels and – for households with a car – transport fuels, with a lower share for electricity consumption.

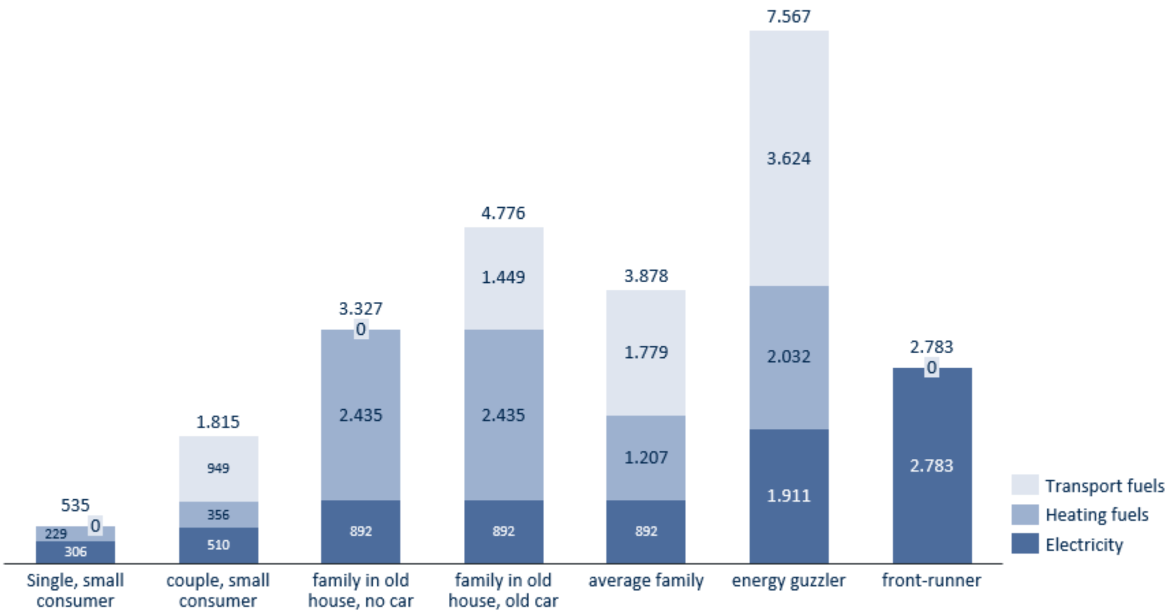


Figure 17 Annual energy expenditures per household archetype without a carbon price (in €/year)

With a carbon price of €40/t, at constant consumption levels energy expenditures for heating and transport fuels increase with approximately 12% to 23% depending on the household archetypes. The impact then increases as the carbon price increases, ranging between 25% and 57% under a €100/t carbon price.

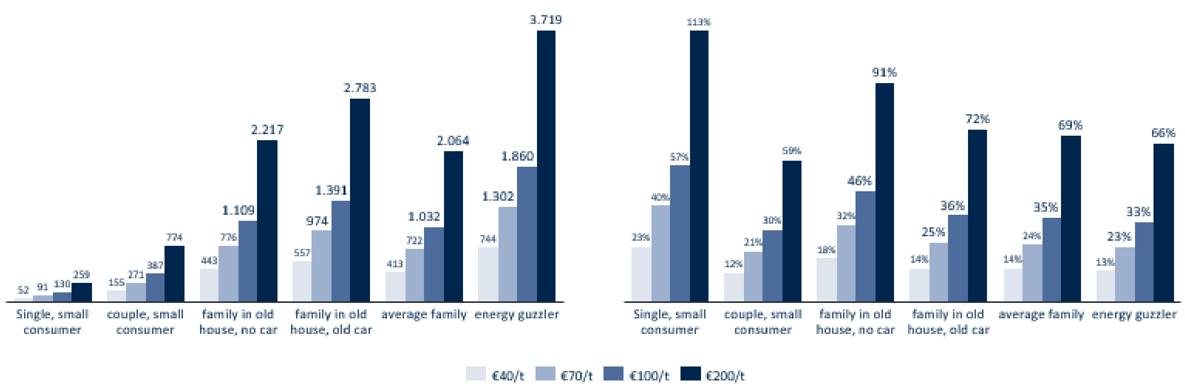


Figure 18 Impact of a carbon price on annual transport and heating fuel expenditures per household archetype, in €/y (left) and % increase (right)

Note that the relative increase is largest for households without a car and heating with natural gas (e.g. the single). The relative increase is less pronounced for the household without a car but heating with fuel oil (the family living in an old house without a car), and is the lowest for households where transport fuels take an important share of overall expenses (e.g. the 'energy guzzler' or the 'front runner'). This is because of the relative impact of a carbon price on the different energy carriers. For heating fuels – for which there are currently low distribution costs, taxes and levies, a carbon price will have a high relative impact on the final price per unit, with the impact on natural gas the highest. For transport fuels – where existing taxes and levies are much higher – the relative impact of a carbon price is much lower. This is also illustrated in figure 11 below: whereas the absolute increase due to a carbon price of €100/t is comparable between the different energy carriers, the relative increase differs significantly due to the unbalance in other cost components (distribution, transmission and existing taxes and levies).

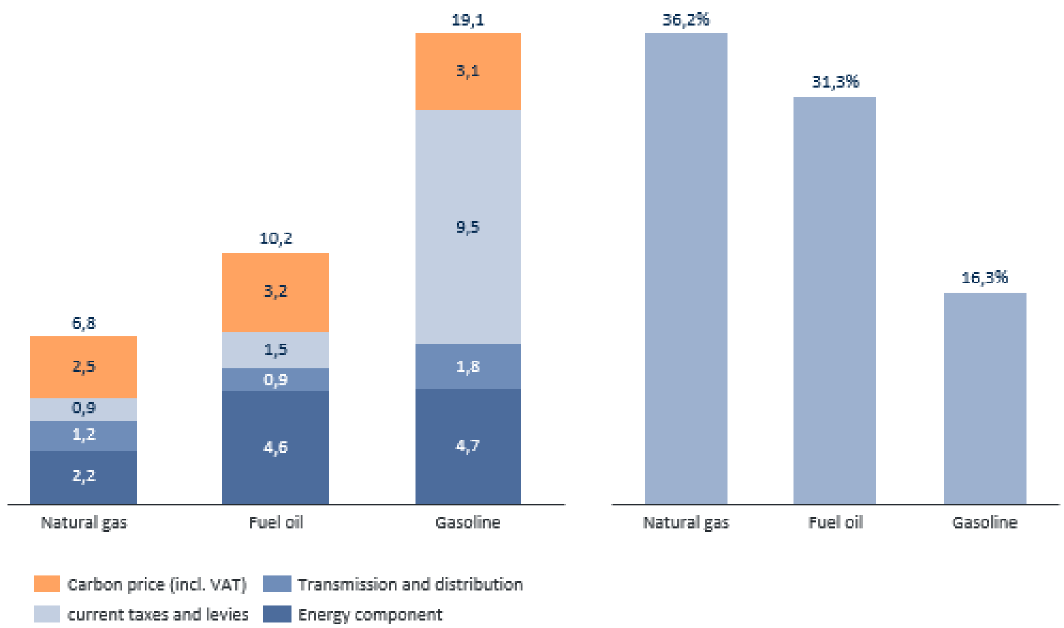


Figure 19 Impact of a €100/t carbon price on energy prices, in c€/KWh (left) and in % increase (right)

Impact based per income quartile (before revenue recycling)

According to Statbel data, the average Flemish household spends approximately € 2600 per year on energy products. On average, there is a correlation between income and energy expenditures, with the 25% lowest incomes spending 30% less than the Flemish average, and the 25% highest incomes spending 25% more. This correlation is strongest for transport fuels. The households with the highest income spent 40% more on transport fuels than the Flemish average. The demand of electricity shows a lower spread. The households with the highest income only spend 13% more on electricity compared to the Flemish average. Transport fuels and electricity represent the largest share of expenditures, with heating fuels only representing +- 25%. It should be noted that these numbers represent averages, and strong differences might occur within each income quartile.

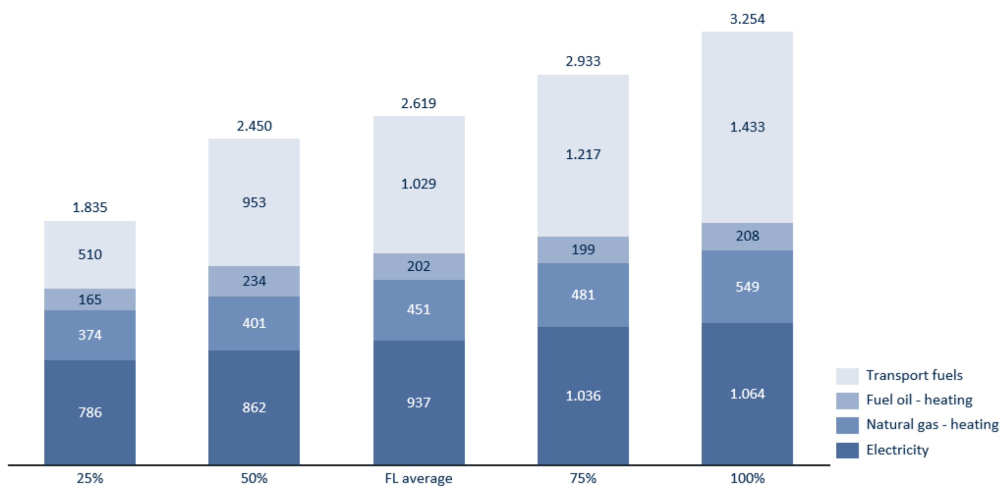


Figure 20 Annual energy expenditures per household per income quartile (in €/year)

With a carbon price of €40/t, at constant consumption levels overall expenditures for heating and transport fuels increase with approximately 11% across all income quartiles, increasing to 27-31% under a €100/t carbon price. Again, we see that the relative increase decreases for higher income households, due to the higher share of transport fuels in their overall energy expenses (and the fact that the relative impact of a carbon price on transport fuels is limited due to other, existing taxes and levies).

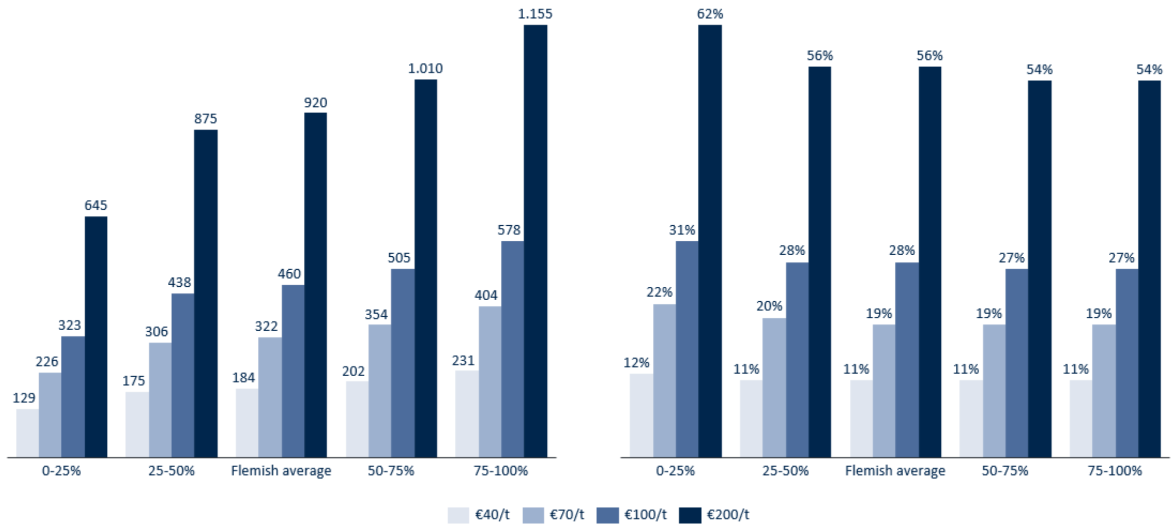


Figure 21 Impact of a carbon price on annual transport and heating fuel expenditures per income quartile, in €/y (left) and % increase (right)

The impact on transport and heating fuels are lower when assessed based on income quartile compared to our previous assessment per household archetype, mainly because of the lower share of heating fuels in total energy expenditures. Nevertheless, it confirms that a carbon price of €40 to €100/t – which is the expected when implementing emission trading for the buildings and transport sector – can have a tangible impact on overall energy expenditures of Flemish households. There are however important levers than can be implemented to lower this impact:

1) Lower overall energy consumption and decarbonize the energy mix used: this is ultimately the goal of applying a carbon price through emission trading. By making fossil energy consumption more expensive, households are incentivized to consume less energy and/or to switch to non-fossil alternatives, thereby reducing costs. In the buildings and transport sector, this often requires time and high upfront investments. Therefore, a gradually increasing carbon price signal – providing households sufficient time to adapt – is preferable over a sudden, high price from the start. Furthermore, specific investment support might be required for low-income households with low investment capacities. This could be financed with auctioning revenues (see next point);
2) The recycling of auctioning revenues: emission trading is expected to generate significant auctioning revenues, which can be (partially) used to mitigate undesired social impacts of the carbon price and to support vulnerable households and companies in the transition.

The Commission's proposal provides that all auctioning revenues generated via the new emission trading system should be used to finance both levers, both via direct use by member states as via the Innovation Fund (150 million allowances) and the Social Climate Fund (€ 56 billion in the period 2026-2030, which is expected to correspond to 25% of all auctioning revenues).

c. Impact on companies

Impact on energy expenditures

Figure 22 below shows the current energy expenditures per company type described in section 5.1. As can be expected, there are strong differences both in terms of overall expenses as well as the respective shares of electricity, natural gas and transport fuels between the different company types. For the service company and especially the logistics company, transport fuel expenditures represent the bulk of energy expenditures. For a bakery, electricity represents approximately 50% of energy expenditures, with transport and natural gas accounting for +-25% each.

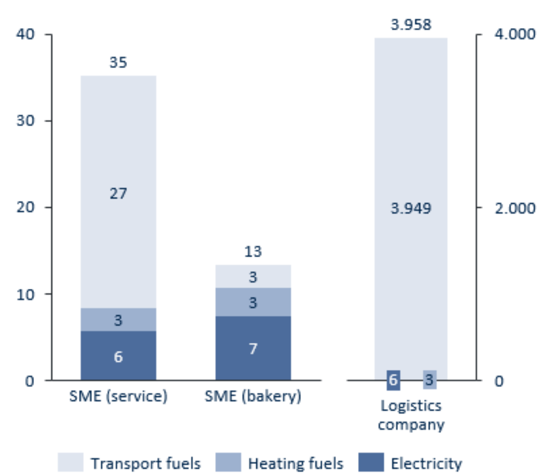


Figure 22 Annual energy expenditures per company archetype without a carbon price (in k€/year)

Overall, energy expenditures would increase with 9-14% under a €40/t carbon price, and 23-36% under a €100/t carbon price. However, there are differences between different company types depending on their consumption profile. Overall, the relative increase is smaller for companies with relatively high transport fuel expenditures, and higher for companies that have a higher share of heating expenditures. This is due to the same dynamics as identified for households (low relative impact of a carbon price on transport fuels).

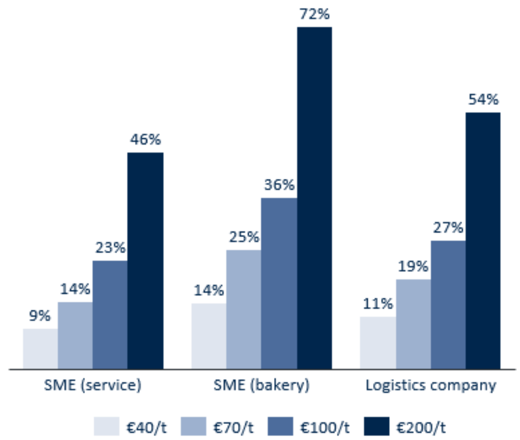


Figure 23 Relative increase in heating and transport fuel expenditures per company archetype (in %)

d. Auctioning revenues and possible uses

In the previous section we have assessed that a carbon price within the expected price range (€40 to €100/t) could have a significant impact on energy expenditures of both households and companies. On the other hand, the revenues from emission trading would also – at least partially – flow back to the Flemish Region. According to the Commission's proposal, these revenues will have to be used to reduce adverse impacts on vulnerable households and companies and to further support emission reductions.

Overall auctioning revenues

Under the Commission's proposal, Flanders is expected to auction a little over 100 million allowances under the new system between 2026-2030. After accounting the impact of the Social Climate Fund, **total available revenues would range between €2,6 –7,9 billion over the period 2026-2030**, depending on the carbon price.

Revenues would be highest in 2026, when significantly more allowances are auctioned due to the frontloading provision. After that, revenues decrease as the volumes decrease (due to a decreasing cap in combination with the frontloading provision). Under the €70/t and €100/t price trajectories, the decrease in volume is partially offset by the increase in the carbon price.

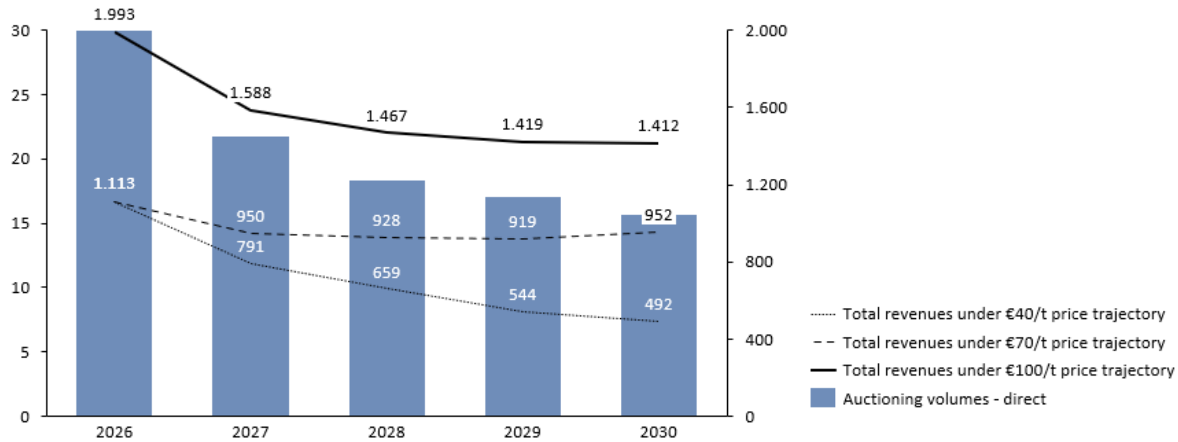


Figure 24: expected auctioning volumes (left axis, in million allowances) and revenues (right axis, in € million) for Flanders

This figures include the impact of the Social Climate Fund. Based on the assumptions used, Flanders would in total contribute €1270 million to that fund (€180 million per year in 2026-2028, which would increase to almost €370 million per year as of 2029). On the other hand, it could also receive up to €850 million from the Fund (€120 million per year in 2026-2028, increasing to €345 million as of 2029). The net contribution for Flanders over the period 2026-2030 would be €420 million. Without taking into account the revenues from the Social Climate Fund, direct auctioning revenues would range between €2,7 billion under the €40/t price trajectory, up to €7 billion under the €100/t price trajectory.

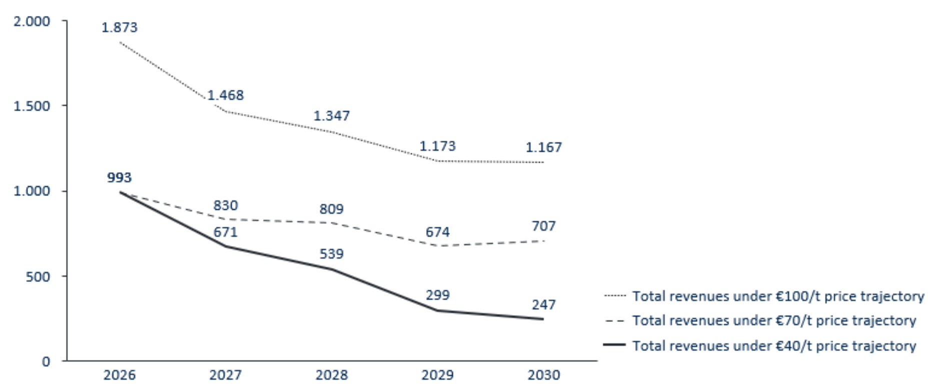


Figure 25 Projected auctioning revenues in 2026-2030 for the Flemish Region excluding revenues from the SCF (in € million)

Based on current shares in emissions, about two thirds of the revenues would come from households (residential buildings and passenger transport), with freight transport and non-residential buildings accounting for the other third. The average available amount of auctioning revenues per household – assuming the two-thirds share above – would be €158/y under a €40/t carbon price trajectory, €214/t under a €70/t price trajectory and €346/t under a €100/t price trajectory.

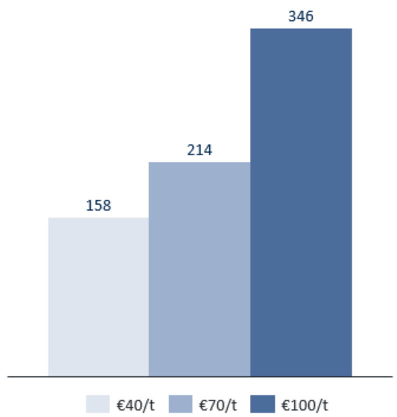


Figure 26: expected available revenues per household (in €/year)

Use of auctioning revenues

The Commission's proposal requires revenues to be used to support the transition in the transport and buildings sector as well to address the social impacts of the emission trading system, with a specific focus on vulnerable households, vulnerable micro-enterprises and vulnerable transport users, i.a. via the newly proposed Social Climate Fund.

6) Administrative costs

In the previous section we have assessed the impact of carbon cost. In addition to these compliance costs there are also additional administrative costs, that will be analysed in this chapter.

a. Estimated administrative costs for the German emission trading system for the transport and buildings

For the German ETS for the transport and buildings sector administrative costs have been estimated in the draft law.[28] The following insights can be gained from the German example: In Germany there are 4045 companies subject to the energy tax. 80% of these companies are estimated to only report standard fuels (natural gas, diesel), while 20% of these companies also report fuels with differentiated emission factors (e.g. waste and coal). Costs of companies with standard fuels are estimated to be only 40% of the costs of companies that report differentiated emission factors. In comparison to the EU ETS monitoring costs are estimated to be 50% lower, because the data already is collected for the energy tax and only the emission factor needs to be multiplied with the amount of fuel sold. Costs that only occur once such as the setup of an account in the registry have been annualized and were distributed to the years of the trading period.

Administrative costs for companies have been estimated at a level of 11,300 € per company and year. The cost for companies includes the following cost components:

- Monitoring of emissions (84% of the administrative costs)
- Setup and adjustments of the monitoring plan (15% of the administrative costs)
- Setup of an account in the registry (1% of the administrative costs)

[28] https://www.bmu.de/fileadmin/Daten_BMU/Download_PDF/Glaeserne_Gesetze/19._Lp/behg_refe/Entwurf/behg_refe_bf.pdf

There are also administrative costs for the public sector (competent authority). For Germany the following annual costs were estimated: 1650 € per year (17 working hours) per case.[29] This includes the following work steps:

- Checking of the emission reports (32% of the administrative costs)
- Checking of the monitoring plan (42% of the administrative costs)
- Setup of an account in the registry (10% of the administrative costs)
- Management of registry accounts (16% of the administrative costs)

b. Estimate for administrative costs of an emission trading for fuels use (non ETS sectors) in Flanders

The Commission's proposal identifies fuel suppliers as the regulated entities under the new ETS. Fuel suppliers are defined as the entity that is liable to pay excise duties in accordance with Council Directive (EU) 2020/262.

In Flanders, there are two types of fuel suppliers that are covered by this definition:

- Authorized warehousekeepers: these operators manage the fuel depots from where fuels are distributed to gas stations (transport fuels) or individual buildings (heating fuels). Based on information received from the Federal Public Service for Finance, there are 315 authorized warehousekeepers registered, of which 231 in Flanders.
- Natural gas distributors: according to the website of the Flemish Energy Regulator (VREG), there are 33 entities with a license to distribute gas in Flanders.

The total number of covered entities would thus be 264, which is higher than the amount of operators covered by the existing EU ETS (+- 200). Nevertheless, when assuming the estimated administrative costs in Germany, overall administrative costs are expected to remain limited:

[29] The mentioned costs are only the costs occurring in the German emission authority for the pure emission trading. Cost for special rules such as a financial compensation for carbon leakage sectors are not included. Costs according in other administrative bodies are also not included (e.g. in the financial administration).

about €3 million per year for Flemish businesses, and €400k per year for public authorities. Of this €400k, about 75% would be related to permitting and the monitoring, reporting and verification cycle (for which Flanders is assumed to be competent, in line with the current EU ETS), and the other 25% would relate to administering the registry account (which in Belgium is administered by the Federal Public Service for Health and Environment). The administrative cost for the Flemish administration is therefore estimed to be €325k per year.

The administrative costs are there, but they are not the core element that should guide the design of an ETS. In the German example for an emission trading system for the transport and buildings sectors administrative costs are only 1% of the CO_2-costs under full auctioning (compliance costs).[30] This shows that administrative costs are not the central cost factor.

30 Based on the cost for compliance (to buy CO_2-Certificates) in 2021 of 6 billion Euro. This equals to compliance costs of 1.5 million € per company. Source for compliance costs: https://www.oeko.de/fileadmin/oekodoc/CO2-Bepreisung_und_die_Reform_der_Steuern.pdf

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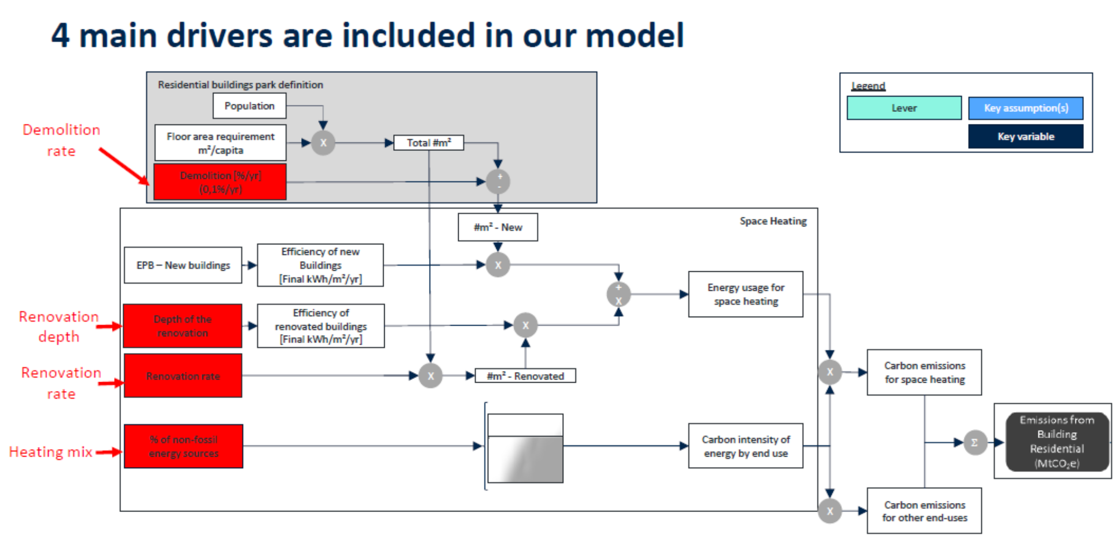
Annex: underlying assumptions of the Flemish emission scenarios

Buildings

Model methodology

The model we have used in the context of this study allows to model energy demand and emissions in function of a number of parameters or 'levers'. To determine emissions from the buildings sector, our model takes into account a wide range of parameters as shown in the figure below. A number of these parameters are assumed to be exogenous (e.g. demographic developments, floor requirement per capita) and others are considered to be policy driven (the so-called 'levers' that can be used to reduce emissions). For the development of the scenarios for this study, we have focussed on 4 main levers: the demolition rate (% of existing buildings that are demolished each year), the renovation rate (% of buildings that are renovated each year), the renovation depth (achieved efficiency after renovation, expressed in energy use/m^2), and the heating mix (% of different heating technologies to meet overall heating demand). These policy levers can be differentiated between residential and tertiary buildings, meaning that e.g. a different renovation rate can be assumed for both types of buildings.



The underlying assumptions for each of these 4 levers are provided in the tables below.

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Assumptions for the residential sector

	Renovation rate	Demolition rate	Renovation depth[1]	Share of non-fossil heating
2020 starting point	1,25%	0,1%	80% shallow 15% medium 5% deep	25% in new-built dwellings 5% in renovated dwellings
2030 under baseline	1,25%	0,1%	60% shallow 22,5% medium 7,5% deep	75% in new-built (as of 2025) 5% in renovated
2030 under €40/t – no ESR	1,25%	0,1%	No change to baseline	Same as baseline
2030 under €70t/ - no ESR	1,25%	0,1%	No change to baseline	85% in new-built (as of 2025) 10% in renovated (as of 2025)
2030 under €100/t – no ESR	1,25%	0,1%	40% shallow 50% medium 10% deep	90% in new-built (as of 2025) 30% in renovated (as of 2025)
2030 under €40/t – ESR	2,5% (as of 2025)	0,2% (as of 2025)	20% shallow 65% medium 15% deep	75% in new-built (as of 2023) 25% in renovated (as of 2025)
2030 under €70t/ - ESR	2,5% (as of 2025)	0,2% (as of 2025)	Same as €40/t - ESR	85% in new-built (as of 2023) 40% in renovated (as of 2025)
2030 under €100/t – ESR	2,5% (as of 2025)	0,2% (as of 2025)	0% shallow 80% medium 20% deep	95% in new-built (as of 2023) 60% in renovated (as of 2025)

[1] A 'shallow' renovation reduces the heat demand per m^2 by 15%. After a medium renovation, heat demand is decreased by 43%. After a deep renovation, heat demand is reduced by 78%. These impacts are consistent with observed energy efficiency improvements in Belgium following different renovation types (IPSOS & Navigant, 2019)

Assumptions for the tertiary sector

	Renovation rate	Demolition rate	Renovation depth[1]	Share of non-fossil heating
2020 starting point	1%	0,1%	80% shallow 15% medium 5% deep	50% in new-built dwellings 25% in renovated dwellings
2030 under baseline	2,5% (as of 2025)	0,2% (as of 2025)	20% shallow 65% medium 15% deep	75% in new-built (as of 2025) 35% in renovated (as of 2025)
2030 under €40/t – no ESR	Same as baseline	Same as baseline	Same as baseline	80% in new-built (as of 2025) 40% in renovated (as of 2025)
2030 under €70t/ - no ESR	Same as baseline	Same as baseline	Same as baseline	85% in new-built (as of 2025) 50% in renovated (as of 2025)
2030 under €100/t – no ESR	Same as baseline	Same as baseline	Same as baseline	95% in new-built (as of 2025) 70% in renovated (as of 2025)
2030 under €40/t – ESR	Same as baseline	Same as baseline	Same as baseline	80% in new-built (as of 2023) 60% in renovated (as of 2023)
2030 under €70t/ - ESR	Same as baseline	Same as baseline	Same as baseline	85% in new-built (as of 2023) 70% in renovated (as of 2023)
2030 under €100/t – ESR	Same as baseline	Same as baseline	0% shallow 80% medium 20% deep	95% in new-built (as of 2023) 90% in renovated (as of 2023)

[1] the impact of shallow, medium and deep renovations is differentiated between different types of tertiary buildings.

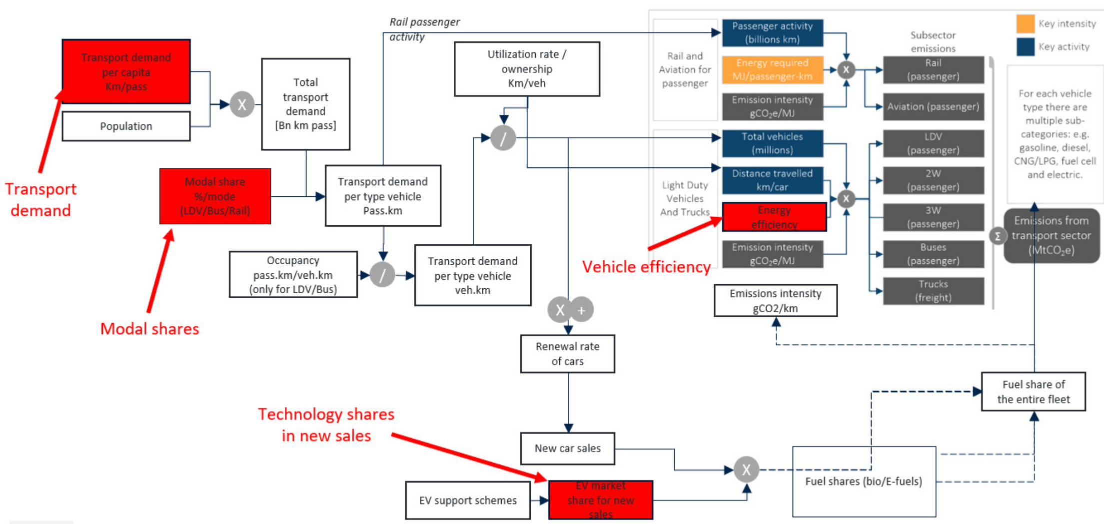
Transport

Model methodology

Similar as to the buildings sector, a number of 'levers' were used to develop emission scenarios for the transport sector in function of a) a carbon price and b) the assumed impact of complementary policies triggered by the Effort Sharing Regulation. These levers can be differentiated between passenger and freight transport, to take into account specific characteristics for both sub-sectors. Overall, four key levers were identified and used in the context of this study:

- Overall transport demand (km/passenger for passenger transport, absolute vkm's for freight transport);
- Modal split (the respective modal share of each transport mode to meet overall transport demand);
- The share of Zero Emission Vehicles (ZEVs) and of Low Emission Vehicles (LEVs) in new sales;
- The overall energy efficiency of the entire road transport fleet.

Other levers – such as overall population growth, vehicle occupancy, share of bio- and E-fuels and the specific technology mix of Low Emission Vehicles were assumed to remain constant across all scenarios.



Assumptions for the passenger transport sector

	Transport demand (per capita[1])	**Modal share for cars**	**Vehicle efficiency**	**ZLEV % in new sales**
2020 starting point[2]	13300 pkm per capita	78% in non-urban areas 64% in urban areas		4% of ZEVs in new sales 9,3% of LEVs in new sales
2030 under baseline	Stable	Stable	6% improvement compared to 2020	25% of ZEVs in new sales 22% of LEVs in new sales
2030 under €40/t – no ESR	-0,6% compared to baseline	-0,4% compared to baseline	Same as baseline	Same as baseline
2030 under €70t/ - no ESR	-1% compared to baseline	-0,6% compared to baseline	8% improvement compared to 2020	30% of ZEVs in new sales 29% of LEVs in new sales
2030 under €100/t – no ESR	-1,4% compared to baseline	-0,9% compared to baseline	9% improvement compared to 2020	35% of ZEVs in new sales 35% of LEVs in new sales
2030 under €40/t – ESR	-5,6% compared to baseline	-3,4% compared to baseline	6,5% improvement compared to 2020	30% of ZEVs in new sales 37% of LEVs in new sales
2030 under €70t/ - ESR	-6% compared to baseline	-3,6% compared to baseline	10% improvement compared to 2020	40% of ZEVs in new sales 32% of LEVs in new sales
2030 under €100/t – ESR	-6,4% compared to baseline	-3,9% compared to baseline	12,5% improvement compared to 2020	50% of ZEVs in new sales 27% of LEVs in new sales

[1] Overall, population is assumed to increase with 3% between 2020 and 2030. Therefore, overall transport demand increases under some scenario even if the demand/capita decreases.
[2] Does not take into account the impact of COVID-19. This 2020 starting point was determined based on latest reported data and short-term projections based on historic trends.

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Assumptions for the freight transport sector

	Transport demand (absolute, in tkm's)	**Modal share for trucks**	**Vehicle efficiency**	**ZLEV % in new sales**
2020 starting point[1]	+5% compared to 2015	Not used for freight		0% of ZEVs in new sales 0% of LEVs in new sales
2030 under baseline	+19% compared to 2015	Not used for freight	3% improvement compared to 2020	5% of ZEVs in new sales 18% of LEVs in new sales
2030 under €40/t – no ESR	+18,9% compared to baseline	Not used for freight	Same as baseline	Same as baseline
2030 under €70t/ - no ESR	+18,85% compared to baseline	Not used for freight	5% improvement compared to 2020	6% of ZEVs in new sales 19% of LEVs in new sales
2030 under €100/t – no ESR	+18,8% compared to baseline	Not used for freight	7% improvement compared to 2020	7% of ZEVs in new sales 20% of LEVs in new sales
2030 under €40/t – ESR	+13,9% compared to baseline	Not used for freight	4% improvement compared to 2020	7% of ZEVs in new sales 23% of LEVs in new sales
2030 under €70t/ - ESR	+13,85% compared to baseline	Not used for freight	8% improvement compared to 2020	8% of ZEVs in new sales 26% of LEVs in new sales
2030 under €100/t – ESR	+13,8% compared to baseline	Not used for freight	10% improvement compared to 2020	9% of ZEVs in new sales 29% of LEVs in new sales

[1] Does not take into account the impact of COVID-19. This 2020 starting point was determined based on latest reported data and short-term projections based on historic trends.

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+32 (0) 10 750 740