Update of the impact assessment of federal Policies and Measures

June 2021

In partnership with :

On behalf of :

service public fédéral SANTE PUBLIQUE, SECURITE DE LA CHAINE ALIMENTAIRE ET ENVIRONNEMENT

federale overheidsdienst VOLKSGEZONDHEID, VEILIGHEID VAN DE VOEDSELKETEN EN LEEFMILIEU

Colophon

Details of the mission

Study on the "update of the impact assessment of PaMs and development of a methodology for the monitoring of PaMs from the federal 2021-2030 NECP" - Tender n° DGEM/CC/FD/20003.

Phase 1: Update of the impact assessment of existing PAMs

Study Single Points of Contacts (SPOCs) :

SPOCs	Organisation	Email
Marco ORSINI François TAMIGNEAUX	ICEDD	mo@icedd.be fta@icedd.be
Bruno VAN ZEEBROECK	TML	bruno.vanzeebroeck@tmleuven.be
Juan Luis Martin ORTEGA	Gauss	jlm@gauss-int.com
Tom DAUWE	VITO	tom.dauwe@vito.be

This version: 2021, June 23

Table of contents

List of figures

List of tables

1. Introduction

This report presents the evaluation of GHG emission impacts resulting from the implementation of federal climate Policies and Measures (PAMs). It is an update of the emission reductions assessment conducted in 2017[2].

This evaluation was carried out by a consortium of four organisations (ICEDD, GAUSS, TML and VITO) who could benefit from expertise and data coming from the different concerned public federal administrations. Close interactions were maintained along the process to enrich the methodologies developed in the former edition of the study as well as to collect up-to-date data.

Results derived from this new exercise highlight changes that occurred because of redefining of PAMs scope, methodological changes (i.e. use of 2006 IPCC guidelines emission factors) and the availability of new data.

2. Summary of impacts: emission reductions

The federal government has implemented several policies and measures (PAMs) for abating greenhouse gas (GHG) emissions. This report presents an update of the estimations of emission reduction impacts resulting from the implementation of these PAMs conducted in 2017. As shown in Table 1, federal PAMs for mitigating climate change have been estimated to have a cumulative emission reduction impact of around 89 million tons of CO_2eq over the period 2013-2020 (in a likely scenario). 63% of total reductions relate to emissions from non-ETS sectors, the rest falling under the EU Emission trading scheme (ETS). For the period 2021-2030, cumulative emissions reduction resulting from federal PAMs are estimated to reach 208 million tons. In terms of yearly emissions reduction these results correspond to an average reduction of around 11 million tons CO_2eq./year for the period 2013-2020 and 23 million tons CO_2eq./year for the period 2021-2030.

Period	ETS	non-ETS
2013-2020	33 207.35	55 753.48
2021-2030	90 233.98	118 097.85

Table 1: Total cumulative emission reductions from federal PAMs (2013-2020 and 2021-2030, kiloton CO2-eq., likely scenario). Note: this considers all PAMs except PAM XX-X02 (Green Loan), as the effect of this PAM is incorporated in PAM EC-B01 (tax incentive), as further explained in section 3.27.11).

Most of the reductions in emissions are the result of the implementation of a limited number of PAMs. The four most important PAMs in terms of total (non-ETS and ETS) federal emission reductions are Energy label (EC-A05), Tax incentive to promote energy efficiency in households (EC-B01), Biofuels (TR-D01) and Offshore wind energy & tidal energy (EP-A01/EP-A05). These four PAMs sum up to 76% of cumulative emissions reductions in the period 2013-2020. Figure 1 and Table 2 show the cumulative emissions reductions in ETS and non-ETS sectors for each PAM for the period 2013-2020 and 2021-2030 respectively.

Emissions reductions have been estimated as the difference between the current situation (whenever the PAM has already been implemented) and a baseline, which is a scenario without the PAM. Several assumptions are thus taken to calculate the effect of each PAM. To reduce the impact of uncertainties related to these assumptions, different scenarios (max, min and likely) have been calculated. A conservative approach has been taken in general in the choice and definition of assumptions behind the definition of the different scenarios. The limits of the estimation methodologies have been pointed out for each PAM and offer a base for improving the evaluations in the future.

This study builds on the work on the estimation of federal PAMs done previously, notably the studies published in 2015[1] and 2017[2] (the full list of previous impact assessment studies can be found on the website of the federal climate change service[3]). Methodologies for the estimations have been updated. Table 3 shows the differences between previous and new estimations for cumulative federal emissions (ETS + non-ETS) reductions. The results of the new evaluation evolved compared to previous assessments because of changes in methodology, redefinition of the boundaries of some PAMs or the use of new assumptions (e.g. emission factors), among others.

[1] VITO and Econotec. "Evaluation of the Impact of Policy Instruments and Measures Implemented in the Context of the Federal Climate Policy." Final report. Study Commissioned by the Belgian Federal Public Service of Public Health, Food Chain Safety and Environment, March 4, 2015. https://www.climat.be/files/9214/3193/5459/2015_final_report.pdf.

[2] Orsini, Marco, Inès Sneessens, Bruno Van Zeebroeck, Jeroen Kuenen, Pepa Lopez, Juan Louis Martin, and Alicia Gonzalez Nicolas. "Evaluation of Emission Reductions: Development of Impact Assessment Methods for Policies and Measures Carried out within the Framework of the Federal Climate Policy." ICEDD asbl, Aether, Transport & Mobility Leuven and TNO for the Federal Public Service (FPS) Health, food chain safety and environment - DG Environment - Climate Change Service, June 13, 2017. https://www.climat.be/files/3315/0537/7367/Evaluation_federal_PAMs_July_2017_corr.pdf.

[3] [NL] https://klimaat.be/klimaatbeleid/belgisch/federaal/beleid-en-maatregelen-voor-uitstootverlaging, [FR} https://climat.be/politique-climatique/belge/federale/politique-climatiques-et-mesures-de-reduction-des-emissions

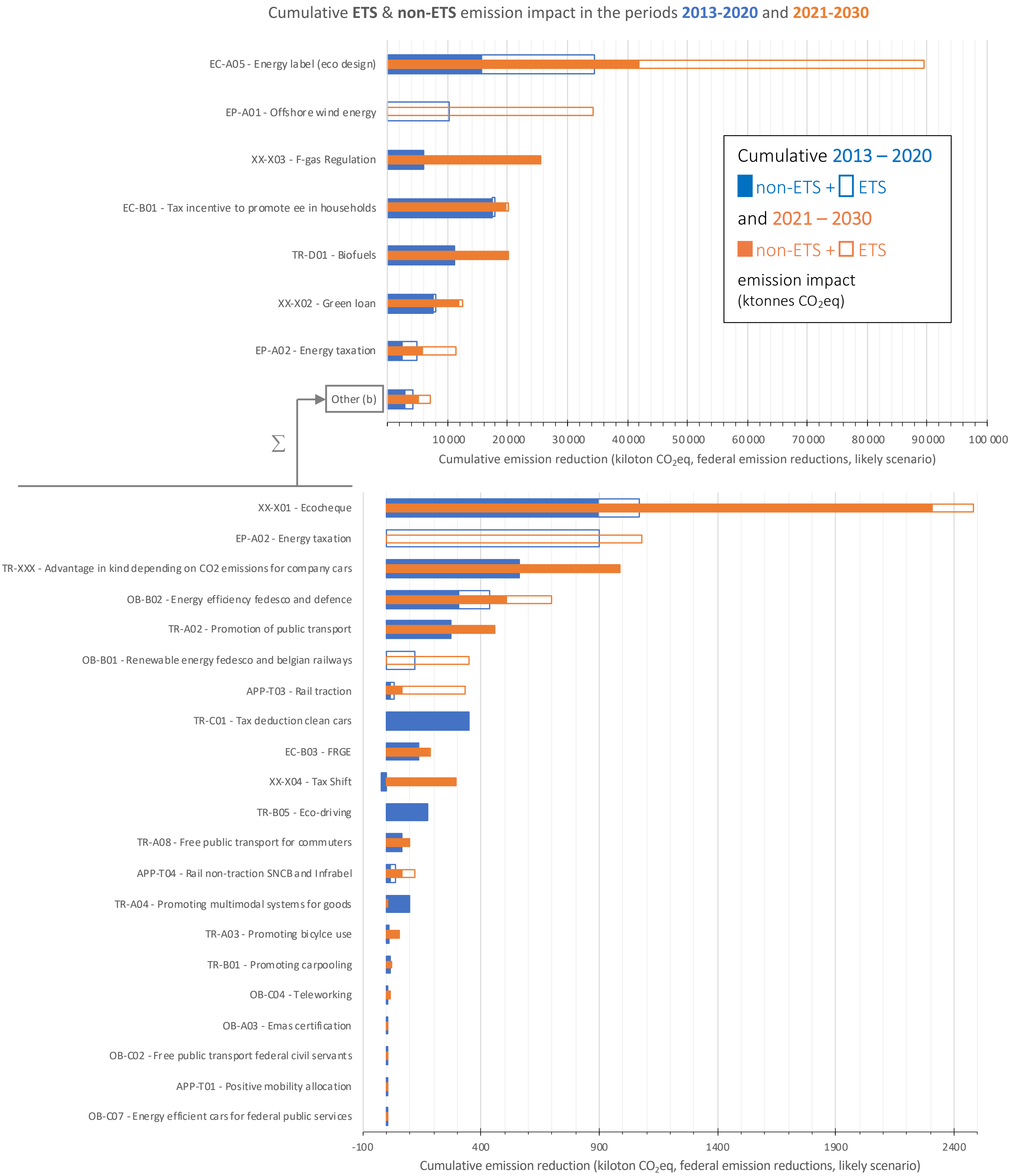


Figure 1: Summary graph of cumulative emission reduction impacts in the periods 2013-2020 and 2021-2030 (likely scenario, kton CO2eq)

PAM code	PAM title	2013 - 2020		2021 - 2030	
		ETS	Non-ETS	ETS	Non-ETS
APP-T01	Positive mobility allocation	0.0	3.5	0.0	4.9
APP-T03	Rail traction	15.3	15.8	270.6	64.4
APP-T04	Rail non traction	24.4	15.8	57.7	63.6
EC-A05	Energy label (eco design)	18 885.9	15 649.8	47 673.1	41 918.8
EC-B01	Tax incentive to promote energy efficiency in households	340.1	17 548.2	425.1	19 761.8
EC-B03	FRGE	0.7	132.0	0.9	181.9
EP-A01 /EP-A05	Offshore wind energy	10 228.7	0.0	34 283.0	0.0
EP-A02	Energy taxation	902.9	0.0	1 079.5	0.0
IP-A06	Tax deduction for energy savings	2 392.2	2 392.2	5 732.2	5 732.2
OB-A03	EMAS	0.0	6.2	0.0	7.1
OB-B01	Renewable energy fedesco and belgian railways	121.3	0.0	348.6	0.0
OB-B02	Energy efficiency fedesco	126.1	308.7	189.9	508.5
OB-C02	Free public transport federal civil servants	0.0	5.4	0.0	4.0
OB-C04	Teleworking	0.0	8.3	0.0	18.8
OB-C07	Energy efficient cars for federal public services	0.0	0.4	0.0	1.7
TR-XXX	Advantage in kind depending on CO_2 emissions for company cars	0.0	561.3	0.0	990.1
TR-A02	Promotion of public transport	0.0	271.3	0.0	461.2
TR-A03	Promoting bicycle use and pedelecs	0.0	12.9	0.0	56.8
TR-A04	Promoting multimodal systems for goods	0.0	99.9	0.0	6.0
TR-A08	Free public transport for commuters	0.0	66.6	0.0	96.8
TR-B01	Promoting carpooling	0.0	19.6	0.0	23.4
TR-B05	Eco-driving	0.0	173.7	0.0	0.0
TR-C01	Tax deduction clean cars	0.0	347.7	0.0	0.0
TR-D01	Biofuels	0.0	11 180.6	0.0	20 161.7
XX-X01	Ecocheque	169.8	897.2	173.3	2 309.0
XX-X02[4]	Green loan	509.9	7 561.6	811.7	11 780.6
XX-X03	F Gases	0.0	6 057.9	0.0	25 431.5

[4] The effect of PAM XX-X02 (Green Loan) is incorporated in PAM EC-B01 (tax incentive), as further explained in section PARTIE A : 3.27.11.

XX-X04	Tax Shift	0.0	-21.6	0.0	293.5

Table 2 : Cumulative emission reduction from federal PAMs (2013-2020 and 2021-2030, kiloton CO2-eq., likely scenario)

PAM code	PAM title	Assessment 2021	Assessment 2017	Assessment 2015
APP-T01	Positive mobility allocation	3.5	51.8	NE
APP-T03	Rail traction	31.2	27.2	NE
APP-T04	Rail non traction	40.2	16.7	NE
EC-A05	Energy label (eco design)	34 535.7	32 177.4	21 485.7
EC-B01	Tax incentive to promote energy efficiency in households	17 888.2	18 094.5	18 018.1
EC-B03	FRGE	132.7	132.0	96.4
EP-A01	Offshore wind energy	10 228.7	10 618.0	14 093.7
EP-A02	Energy taxation	902.9	643.9	1 104.8
IP-A06	Tax deduction for energy savings	4784.5	4 946.2	7 210.4
OB-A03	EMAS	6.2	21.2	23.4
OB-B01	Renewable energy fedesco and belgian railways	121.3	48.7	108.8
OB-B02	Energy efficiency fedesco	434.8	591.2	564.4
OB-C02	Free public transport federal civil servants	5.4	2.5	2.1
OB-C04	Teleworking	8.3	16.9	11.8
OB-C07	Energy efficient cars for federal public services	0.4	0.2	0.2
TR-XXX	Advantage in kind depending on CO_2 emissions for company cars	561.3	577.3	NE
TR-A02	Promotion of public transport	271.3	189.6	2 093.2
TR-A03[5]	Promoting bicycle use and pedelecs	12.9	9.6	63.3
TR-A04	Promoting multimodal systems for goods	99.9	52.7	56.9
TR-A08	Free public transport for commuters	66.6	77.2	544.9
TR-B01	Promoting carpooling	19.6	18.1	77.8
TR-B05	Eco-driving	173.7	387.4	574.8
TR-C01	Tax deduction clean cars	347.7	347.7	568.0
TR-D01	Biofuels	11 180.6	10 959.2	11 134.5
XX-X01	Ecocheque	1 067.0	1 067.0	1 008.8
XX-X02[6]	Green loan	8 071.5	1 028.6	1 028.4
XX-X03	F Gases	6 057.9	4 313.0	NE
XX-X04	Tax Shift	-21.6	183.3	NE

NE: Not evaluated – negative values are for increases in emissions

Table 3: Comparison with the previous results (ICEDD. AETHER. TML & TNO. 2017; VITO-ECONOTEC. 2015): total cumulative emissions reduction from federal PAMs (2013-2020, Kiloton CO_2-eq., likely scenario)

[5] Results from PAMs APP-T02 (pedelecs) and TR-A03 (bicycles) were aggregated in a single PAM TR-A03 (bicycles). See section 3.3 for further details.

[6] The effect of PAM XX-X02 (Green Loan) is incorporated in PAM EC-B01 (tax incentive), as further explained in section PARTIE A : 3.27.11.

The values presented in the tables above were, for some specific PAMs, derived from the electricity emission factor “marginal” method (see section 3.1). To offer a basis for comparison, appendix 5.1 compiles emissions reduction estimates derived from an alternative method, the “average” electricity emission factor.

3. Updated policy and measures: methodology, results and discussion

3.1. Methodology

The assessment of emission reductions derived from PAMs is based on various hypotheses specific to each PAM and detailed in their respective sections. Yet, some subsets of PAMs share common evaluation hypotheses, in particular emission factors. Section 3.1.1 below explains the main hypotheses used in this report.

For some PAMs, there was a methodological need to use a federal allocation factor to distinguish between the emission impact of a federal government policy and national and/or EU-wide policies. Section 3.1.2 contains a generic overview of the different approaches used to allocate observed higher-level impacts to the PAMs under study.

3.1.1. Emission factors of electricity

This section aims to explain the (A.) approach and (B.) sectoral emission factor data and hypotheses used for emission impact-evaluation of policies and measures (PAMs) that are influenced by the emission factor of electricity production.

A. Approach

The choice of emissions factors (EF) of electricity has a substantial impact on the impact estimation of PAMs. As supported by for example Falconer (2009)[7] and Harmelink et al. (2012)[8], two distinct approaches can be used for either (1) *attributing emissions* to electricity that is produced or consumed or (2) estimating the *emission impacts* resulting from changes in the electricity production park (for example the production of renewable energy):

1. "Average method" using the average emissions factor of the total historical (for ex-post assessment) or projected (for ex-ante assessment) electricity production park
2. "Marginal (power plant) method" using the emission factor of the electricity production source that would have been used if the PAM would not have been implemented (for example the electricity produced when no offshore wind energy would have been installed).

The first method has the merit of simplicity as it is based on the historical emission factor (at least for ex-post evaluation). For ex-ante evaluation of PAMs that result in future changes in the electricity production park, the historical emission factor is to be preferred to the emission factor resulting from projections. Otherwise, one would incur double counting of emission reductions as changes in the EF are captured by the impact of PAMs.

The second method seems more sound in methodological terms. The choice of the EF used for estimating the emission impact of a PAM that alters the electricity production park, should come down to what was or will be the most likely electricity generation source or mix if the PAM would not have been implemented. In the case of large energy projects such as offshore wind parks, this could be for example investments in new fossil-fuel capacity such as Combined Cycle Gas Turbines (CCGT). Even in a case where no new investments in fossil fuel capacity would have been needed, the electricity produced by offshore wind turbines would have most probably displaced the electricity that is currently produced by a CCGT since 'must-run'

[7] Forster, Daniel, Angela Falconer, Marco Buttazoni, James Greenleaf, and Wolfgang Eichhammer. "Quantification of the Effects on Greenhouse Gas Emissions of Policies and Measures." Final Report. AEA group for the European Commission, December 2009. https://ec.europa.eu/clima/sites/default/files/strategies/2020/docs/ghgpams_report_180110_en.pdf. Page 99.

[8] Harmelink, Mirjam, Lex Bosselaar, Joost Gerdes, Piet Boonekamp, Reinoud Segers, Hans Pouwelse, and Martijn Verdonk. "Berekening van de CO2-emissies, het primair fossiel energiegebruik en het rendement van elektriciteit in Nederland." Agentschap NL, Centraal Bureau voor de Statistiek (CBS), Energieonderzoek Centrum Nederland (ECN) en Planbureau voor de Leefomgeving (PBL), September 2012. https://www.rvo.nl/sites/default/files/Notitie%20Energie-CO2%20effecten%20elektriciteit%20Sept%202012.pdf. Page 2.

technologies (e.g. nuclear) should not be (or to a much lesser extent) affected by increases in RES or by changes in electricity demand.

The choice of the historical *average* EF would be very close to the choice of the *marginal* EF in case no new investments would be crowded out by the new renewable capacity promoted by the PAM. Hence, the emission factor of the electricity generation park would be homogenous in terms of emissions and priority. This is not the case for Belgium as for the moment all new electricity production from renewables will only have a very limited impact on the nuclear electricity production.

For this reason, we recommend the use of an EF reflecting the type of plants that will be displaced by the renewable projects promoted by the PAMs, at least for the period 20-25 (if no lifetime extension of the nuclear production fleet is considered). After that date, according to current plans of replacing nuclear capacity with new CCGT capacity, it could be that the EF to be used for impact assessment would decrease as new (and with a lower EF) plants could be impacted by new renewable capacity. For the reasons mentioned above, this study follows the “marginal” method. Yet, appendix 5.1 compares results when following the “average” method.

B. Hypotheses

B.1. Electricity production emission factor

This emission factor addresses electricity production. Due to the implementation of PAMs, it is assumed that the electricity would not have been produced in a combined cycle gas turbine (CCGT) power plant. In the previous report, an emission factor of 380 g CO_2/kWh was used and was based on the CO_2 emission factor from natural gas (56.1 kg/GJ (IPCC 2006 Guidelines) and an assumed efficiency of 53%, resulting in a net emission factor of 56.1 / 53% * 3.6 = 380 g CO_2/kWh. This EF has been updated in the present assessment. As nuclear phase-out is planned by end 2025, we assume new capacity from CCGT power plants, which are more efficient than old ones would be added to the grid as of 2023. It would take 3 years to fully replace nuclear power plants by new CCGT power plants whose efficiency rate is assumed to rise linearly to reach 58% by 2026, which results in a net emission factor of 56.1 / 58% * 3.6 = 348 g CO_2/kWh. As more efficient CCGT power plants are first mixed with old ones, we assume the electricity park production to reach a 60% efficiency by 2040 along with the dismantlement of older plants.

Table 4 below details the calculated electricity EF over time. Besides, we applied a grid loss factor (4.5%) to the below-mentioned electricity emission factors.

Year	Electricity EF (kg/kWh)	Year	Electricity EF (kg/kWh)	Year	Electricity EF (kg/kWh)
2004	0.38	**2020**	0.38	**2036**	0.35
2005	0.38	**2021**	0.38	**2037**	0.35
2006	0.38	**2022**	0.38	**2038**	0.35
2007	0.38	**2023**	0.37	**2039**	0.35
2008	0.38	**2024**	0.36	**2040**	0.34
2009	0.38	**2025**	0.36	**2041**	0.34
2010	0.38	**2026**	0.35	**2042**	0.34
2011	0.38	**2027**	0.35	**2043**	0.34
2012	0.38	**2028**	0.35	**2044**	0.34
2013	0.38	**2029**	0.35	**2045**	0.34
2014	0.38	**2030**	0.35	**2046**	0.34
2015	0.38	**2031**	0.35	**2047**	0.34
2016	0.38	**2032**	0.35	**2048**	0.34
2017	0.38	**2033**	0.35	**2049**	0.34
2018	0.38	**2034**	0.35	**2050**	0.34
2019	0.38	**2035**	0.35		

Table 4: Electricity Emission Factor

- **Other fuel types:** Default emission factors from IPCC 2006 Guidelines are followed as specific EFs used by fuel in the industry and commercial/residential sector are not accessible in the national inventory
- **Emission factors for passenger transport :** This evaluation adapts emission factor of electricity of passenger transport (rail and road) to make it coherent with the marginal emission factor of electricity production (see above).

B.2. Rail emission factor in g CO_2/pkm

We used marginal electricity generation EF (kg CO2/kwh) in combination with energy need per pkm (kwh/pkm) to replace the previous average rail emission factor. We got the energy need per pkm from the NMBS/SNCB (Charlotte Dekeyser).

B.3. Emission factor car

We updated car emission factors by emission factors VITO provided for Flemish climate policy exercise. The emission factor used is the average emission factor of what they called their BAU (BAU-SOREF19) and their ambitious (S2VKP-CPT2017-19). This ambitious scenario has an important uptake of EV's, with 70% of EV's in 2040 in the vehicles stock. In 2030, 50% of the newly registered vehicles are EV's and 100% in 2035 and the years after 2035. The Flemish BAU scenario is a scenario where car type shares do not evolve compared to 2019. This means implicitly that for the scenario we work with for car emissions, 25% of new cars are EV's in 2030 and 50% in 2035.

To interpret this correctly, it is important to keep in mind that in this report we do not evaluate the efforts of the EC or of the regions to promote the use of EV's. We evaluate among other policies to promote public transport, cycling, … To evaluate these policies, the efforts to promote EV's that are in place are part of decided policy.

We added furthermore the indirect emissions of electricity generation of the EV's. We therefore multiplied the average energy consumption[9] (kwh/km) with the CO2 emission of electricity generation (g/kwh) (see above). The reason for this is that also in the past, the indirect emissions of electricity generation of trains were considered to calculate a net emission reduction for the rail policies. We were not able to make the allocation between ETS and non-ETS of the emission reduction and emission increase. One could also argue that there cannot be emission increases in emissions from the electricity sector as these emissions are capped by the ETS system. In the second phase of this project, we can discuss this to come up with transparent hypothesis in line with international reporting guidelines.

Table 5 provides the emission factors per carkm and railpkm as used in our calculations:

Year	Car (g/km)	Train (g/pkm)	Year	Car (g/km)	Train (g/pkm)	Year	Car (g/km)	Train (g/pkm)
2008	177	22.63	**2023**	165	34.77	**2037**	128	30.29
2009	177	22.89	**2024**	162	33.08	**2038**	126	30.29
2010	177	23.59	**2025**	160	30.96	**2039**	123	30.29
2011	177	22.08	**2026**	158	30.29	**2040**	121	29.28
2012	177	22.89	**2027**	156	30.29	**2041**	121	29.28
2013	177	23.59	**2028**	154	30.29	**2042**	121	29.28
2014	177	26.12	**2029**	151	30.29	**2043**	121	29.28
2015	177	28.65	**2030**	149	30.29	**2044**	121	29.28
2016	176	31.18	**2031**	146	30.29	**2045**	121	29.28
2017	175	33.71	**2032**	143	30.29	**2046**	121	29.28
2018	173	36.24	**2033**	139	30.29	**2047**	121	29.28
2019	172	38.76	**2034**	136	30.29	**2048**	121	29.28
2020	171	41.29	**2035**	133	30.29	**2049**	121	29.28
2021	169	43.82	**2036**	131	30.29	**2050**	121	29.28
2022	167	37.19						

Table 5 : Overview of emission factors for car/carkm and train/pkm

[9] https://ev-database.org/cheatsheet/energy-consumption-electric-car

3.1.2. Federal impact allocation

For the majority of the analysed federal PAMs, a clear distinction can be made between the impact of the federal PAM, in relation to other federal and/or regional measures that could impact final emissions of the topic under study.

However, for a small group of PAMs, it was impossible from a methodological point of view to solely derive the impact from an individual (federal) PAM. For these PAMs, the impact of the federal PAMs was calculated using a *federal allocation factor*, representing the federal share of the emission-impact starting from the national or European level.

More specifically, this federal allocation is necessary for PAMs where **(i) final private investments are influenced by fiscal measures of multiple governments** (ex: fiscal energy efficiency measures) or for **(ii) multiple governments invest together in the same final sector or project** (ex: renewable energy investments). In those cases, the *federal allocation factor* is derived based on either (i) the relative share of federal fiscal measures in relation to the total costs and benefits incurred by private investors, or (ii) the federal share of total governmental investment in a specific project.

A third reason for using a federal allocation factor is when a **(iii) transfer of competences (regionalisation) of the same PAM** took place during the period under study**,** therefore impacting the attribution of the outcome of a specific PAM to the respective governments.

Finally, a federal allocation factor is used if the **(iv) source data for analysis was solely available on the European and/or Belgian level**. In this case, a regional share has been derived according to distribution of competences of the different governments.

Table 6 provides a summary overview of the PAMs that make use of a federal allocation factor. Specific details on the methodological choices regarding the federal allocation factor can be found in the methodological sections of each of the PAMs listed.

PAM code	PAM title	Federal allocation factor method	Methodological section
EP-A02	Energy taxation	(i) final private investment allocation	3.10.2 (p. 61)
XX-X02	Green loan	(i) final private investment allocation	3.27.11 (p. 129)
EC-B01	Tax incentive to promote energy efficiency	(i) final private investment allocation (iii) transfer of competence	3.7.2 (p. 46)
OB-B01	Renewable energy	(ii) multi-government investment	3.13.2 (p. 70)
EC-BO3	FRGE	(iii) transfer of competence	3.8.2 (p. 54)
XX-X03	F-gasses	(iv) regionalisation of source data	3.29.2 (p. 132)

Table 6: Overview of PAMs using a federal allocation factor

3.2. APP-T01: Positive Mobility allocation

This policy was entirely reconsidered. No impact was found.

3.2.1. Description of the PAM

In March 2018, the 'cash for car' system was put in place, to enable employees to exchange their company cars for a **mobility allowance**. Complementary to this, in March 2019, a second alternative for the company car was introduced: the ***mobility budget***.

The employee who wishes to trade in his car for cash or a mobility budget must have had a car for at least 12 months during the past 3 years, of which 3 months uninterruptedly before the application for the allowance. At the same time, the employer must have a system of company cars in place for at least 3 years. The mobility allowance and mobility budget only apply to employees.[10]

The **mobility budget** is equal to the annual gross cost of the company car the employee is entitled to at the moment of the request. With the mobility budget, the employee can choose or combine from 3 different options: 1) use an environmentally friendly company car, emitting a maximum of 100 grams CO_2 per km[11], 2) a budget, free of tax, to spend on sustainable modes of transport (purchase and maintenance of (electric) bicycles, electric motorcycles, public transport, sharing solutions, housing costs), 3) the remainder of the mobility budget will be paid in cash to the employee at the end of the year, without income tax but with a social security tax of 38.07%.

As of the 1st of January 2021, the mobility allowance, or 'cash for car' system, is no longer in place. The Constitutional Court's ruling no. 11/2020 of 23 January 2020, annulled the law of 30 March 2018 concerning the introduction of a mobility allowance.

This PAM results in a reduction of emissions in non-ETS sector.

3.2.2. Analysis of the estimated effects

A. Number of employees that abandoned their company car:

During the previous reporting period, no details of the policy were available and an estimate of the effect of this measure was done based on two scenarios:

- An absolute optimistic scenario where **20%** of company car users abandon their company car. Based on a total of 400 000 company cars (see below), this corresponds to 80 000 company cars.
- A more pessimistic scenario where **5%** of company car users abandon their company car. Based on 400 000 company cars, this corresponds to 20 000 company cars.

The **total number of company cars** is estimated to be 400 000. This estimate was based on the federal planning bureau study which counts 383 000 salary cars in its study on company cars (FPB-Laire, 2016) for 2011 and a study by FPS mobility which estimated 525 000 salary cars by 2020 (FPS mobility-Kwanten, 2016).

The number of employees who opted for the **mobility allowance** (cash for car) between 2018 and 2020, is given in Table 7:

Year	No. of employees/no. of company cars
2018	268
2019	792
2020	1413

Table 7: Estimate of the number of employees making use of a mobility allowance between 2018 and 2020

[10] https://www.fleeteurope.com/en/smart-mobility/belgium/features/belgian-mobility-budget-and-mobility-allowance-explained?a=SBL09&t%5B0%5D=Cash%20for%20car&t%5B1%5D=mobility%20allowance&t%5B2%5D=Mobility%20budget&t%5B3%5D=Belgium&curl=1

[11] Maximum 100 grams of CO_2 per km from 1 January 2020 and maximum 95 grams of CO_2 per km from 1 January 2021.

These numbers are based on the quarterly figures of solidarity contribution for mobility allowance from the National Social Security Office.

Based on total number of 525 000 company cars, in 2020, this corresponds to 0.27% of the company cars.

The number of employees who opted for the **mobility budget** between 2019 and 2020, is given in Table 8.

Year	No. of employees/no. of company cars
2019	5
2020	34

Table 8: Estimate of the number of employees making use of a mobility allowance in 2019 and 2020

Based on total number of 525 000 company cars in 2020 (FPS Mobility-Kwanten, 2016), this corresponds to 0.0065% of the company cars.

Mobility allowance and mobility budget was not a success. By 2020, less than 1500 vehicles have been suppressed thanks to the measure.

We assume that 80% of people having cancelled their company cars no longer use a car. Furthermore, we assume that people cancelling their company cars, drive annually 10 000 km with their company car. The 10 000 km is lower than the average mileage driven by company cars. The reason therefore is that we assume that people cancelling their company car are driving less than average their company car. Three scenarios are calculated, the likely scenario, based on these estimates, a minimum scenario, corresponding to 80% of the reductions achieved in the likely scenario, and a maximum scenario, corresponding to 120% of the reductions achieved in the likely scenario.

As of the 1st of January 2021, the mobility allowance or 'cash for car' system is no longer in place. Only mobility budget will still be in place, of which, so far, only 34 people made use of. We therefore estimate a slow fading out of the effect of this policy by 2026.

3.2.3. Results

CO2 emission reductions of almost 2 ktons were achieved in 2020, thanks to this policy, for the likely scenario.

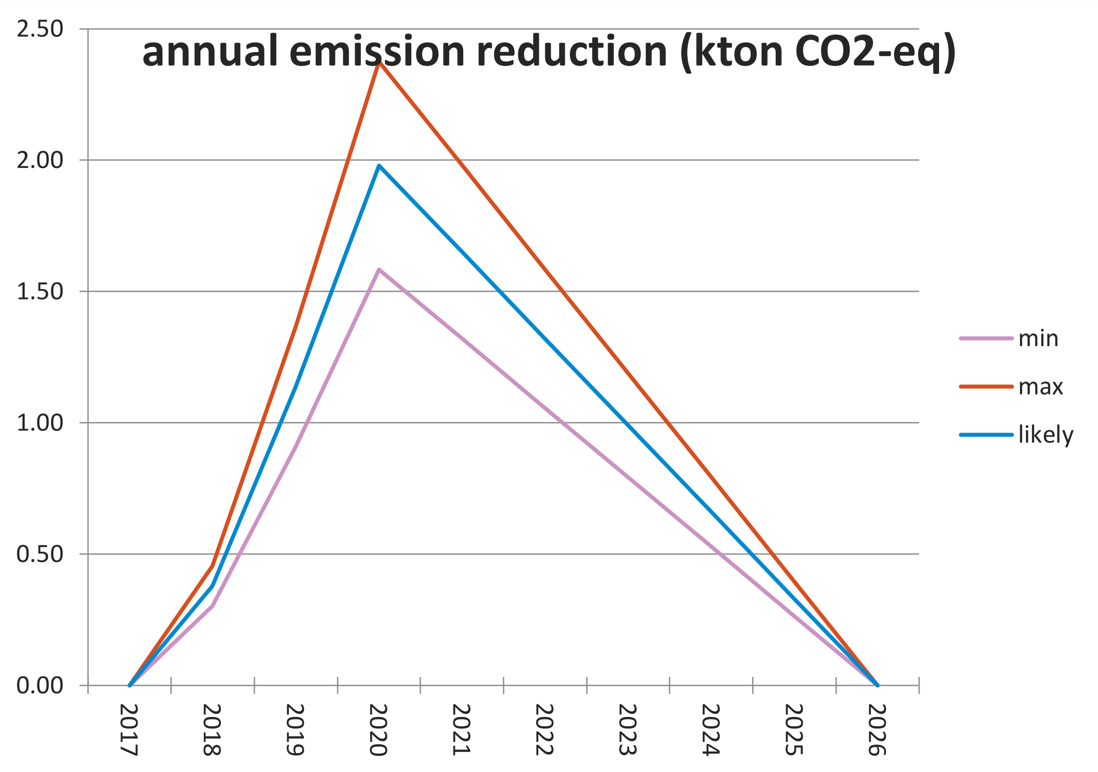


Figure 2: Estimated CO2 emission reductions due to energy savings per passenger-km by NMBS/SNCB Estimated CO2 emission reductions due to the Postive Mobility Allocation PAM (APP-T01)

3.2.4. Sources and references

- Solidarity contribution per number of employers and employees for mobility allowance and mobility budget from Radouane TAHIRI (National Social Security Office)
- Laine, Benoit, and Alex Van Steenbergen. "The Fiscal Treatment of Company Cars in Belgium: Effects on Car Demand, Travel Behaviour and External Costs." Working Paper. Brussels: Federal Planning Bureau, February 2016. https://www.plan.be/publications/publication-1546-nl-the_fiscal_treatment_of_company_cars_in_belgium_effects_on_car_demand_travel_behaviour_external_costs
- Kwanten, Marc. "Kilometers afgelegd door Belgische voertuigen in 2016." Federale Overheidsdienst Mobiliteit en Vervoer, Directoraat-generaal Duurzame Mobiliteit en Spoorbeleid, Directie Mobiliteit, n.d. https://mobilit.belgium.be/sites/default/files/kilometers_2016_nl.pdf
- DIV. Number of company cars via mail exchange with Marc Kwanten

3.3. APP-T02: Incentives for pedelecs

3.3.1. Description of the PAM

The evaluation which follows is based on just a first tentative to come with some elements for evaluating incentives for pedelecs:

- Speedpedelec gets fiscal deductibility of 120% for buying and 22 cent/km (indexed) for using it.
- A 15% income tax reduction for all pedelecs and speed pedelec when bought is added.

This PAM results in a reduction of emissions in the non-ETS sector.

At the end of the study, it was decided that the 15% tax reduction for pedelecs and speed pedelecs when bought will not be implemented.

With the 15% tax reduction not applied, the main remaining part of this PAM is the per km cycling allowance for home-work traffic. This measure is then similar to the TR-A03, promoting bicycle use (except for the fiscal deductibility for speed pedelecs). Therefore, **this PAM is integrated in the TR-A03 and is no longer evaluated separately.**

3.4. APP-T03: Reduction energy use of railways

3.4.1. Description of the PAM

The NMBS/SNCB made efforts to reduce its primary energy consumption per passenger-km via different measures:

- Stimulation of eco-driving through training of drivers
- Reduce energy losses while parked
- Use more efficient rolling stock.
- Increase train occupancy

The initial goal was to reduce the primary energy consumption by 3 to 4% per passenger-km by 2020 compared to 2015. NMBS/SNCB states that this is equivalent to an absolute reduction of 3% of traction energy compared to a baseline with increasing energy use, which means 7.76 ktons of CO_2 (1.18 ktons of diesel and 6.58 ktons of electricity). Further efforts will be made by NMBS/SNCB to reduce its traction energy consumption by 4% per passenger-km in 2022 compared to 2017.

This PAM results in a reduction of emissions in both ETS and non-ETS sectors.

3.4.2. Analysis of impacts and assumptions

Figures were provided by Charlotte Dekeyser from NMBS/SNCB on the energy consumption reductions achieved and prognoses for the coming years, see Table 9 to Table 11. This includes electricity and diesel consumption.

Year	Electricity consumption (electric) (MWh)	Diesel consumption (MWh)	Million passengers
2016	1 069 166	126 540	227.1
2017	1 060 661	123 190	235.3
2018	1 062 010	119 930	243.9
2019	1 061 870	114 640	253.4
2020	1 008 495	111 500	184.1

Table 9: Electricity and diesel consumption in MWh and number of million passengers for the years 2016-2020. Data from NMBS/SNCB (personal communication Charlotte Dekeyser).

We see that energy reductions for electricity and diesel have been achieved with respect to 2016. The lower energy consumption and number of passengers in 2020 can be attributed to the COVID-19 crisis.

These energy reductions have been achieved by:

1. Eco-driving: drivers have more knowledge on the rail track (slopes), make use of the dynamic break and anticipate for red signs.
2. Installing energy meters in the trains to estimate the daily energy consumption.
3. Installation and use of switch off buttons to turn off the basic needs (light, heating) during parking.
4. When possible, lowering of the pantograph while parked.
5. Eco-driving: drivers have more knowledge on the rail track (slopes), make use of the dynamic break and anticipate for red signs.
6. The train fleet will be equipped with new trains like the M7-type.

NMBS/SNCB has been successful in reducing its overall energy consumption between 2016 and 2019 (we do not discuss 2020 for the moment since this is a particular COVID-19 influenced year), while increasing the number of passengers. The number of passenger-km (rkm) increased from 9 927 million rkm in 2015, to 10 167 million rkm in 2017 (communication FOD Mobility), up to 11 067 million rkm in 2019 (see Table 10).

The electricity consumption reduced by 7 296 MWh and the diesel consumption reduced by 11 900 MWh between 2016 and 2019. Based on the average CO_2 emission factor related to electricity production of 381 g/kWh for those years from the National GHG emission inventory, the electricity consumption reduction corresponds to a reduction of 2.78 ktons of CO_2 in 2019 with respect to 2016.

For the diesel consumption reductions, an average emission factor of 325 g/kWh is taken from the report on electrification of the Belgian rail network (TML report for FOD Mobiliteit en Vervoer, 12/2020). This corresponds to the indirect (Well-to-Tank) and direct (Tank-to-Wheel) emissions of the current MW 41 diesel traction. This emission factor is lower than the emission factor for electricity production, since the "marginal" emission factor for electricity production is used. This is explained in detail in section 3.1. Emission factors are expected to decrease from 381 g CO_2/kWh in 2016 to 348 g CO_2/kWh in 2026. The emission factor is expected to stay stable after 2026. and to decrease in 2040 to 337 g CO_2/kWh.

Based on the average emission factor of 325 g/kWh for diesel trains, a reduction of 3.87 ktons of CO2 in 2019 with respect to 2016 was achieved thanks to the diesel consumption reductions.

These CO_2 reductions are obtained despite a 10% increase in passengers which implies an extra energy efficiency gain and thus an extra gain compared to the baseline. To consider the extra passenger-km achieved despite this reduction in electricity and diesel consumption, a factor of 1.1 was applied to the 2.78 ktons and 3.87 ktons of CO_2 reduction.

Year	Energy consumption (MWh)	MWh without energy savings	Energy saving wrt 2019 (MWh)	million passenger-km (million rkm)	Wh/rkm	Wh/rkm decrease since 2019
2019	1 061 870	1 061 870	0	11 067	95.9	
2021	1 068 592	1 084 865	16 273	9 285	115.1	19.90%
2022	1 076 153	1 109 179	33 026	11 022	97.6	1.80%
2023	1 079 311	1 129 374	50 063	11 558	93.4	-2.70%
2024	1 085 315	1 152 951	67 636	11 940	90.9	-5.30%
2025	1 081 580	1 166 481	84 901	12 432	87	-9.30%

Table 10: Projection of the energy consumption per passenger-km (rkm) until 2025. Data from NMBS/SNCB (personal communication Charlotte Dekeyser)

Up to 2025 further electricity consumption reductions per rkm are expected, with energy savings of 84 901 kWh with respect to 2019 if these electricity savings would not have been in place (see Table 10). For after 2025, at this time, it is expected that the electricity consumption is to remain stable, therefore the 2025 value is assumed.

Year	Diesel consumption (MWh)
2019	114 644
2021	113 882
2022	117 546
2023	108 104
2024	107 145
2025	106 196
2026	105 256
2027	104 325
2028	103 404
2029	102 492
2030	101 590

Table 11: Expected diesel consumption reductions in MWh for 2021 to 2030. Data from NMBS/SNCB (personal communication Charlotte Dekeyser).

Expected diesel consumption reductions are shown in Table 11, for up to 2030. These reductions will be achieved thanks to further electrification of the rail network and eco-driving. The expected additional electricity consumption is included in the prognosis of the electricity consumption (Table 10). The main impact on electricity consumption is expected in the year 2021 to 2023. After 2023 the impact on electricity consumption will remain constant. After 2025 the predictions for diesel consumption are very premature.

The current expectation is that diesel trains will be phased out completely from 2035 onwards. This is not taken into account in the calculation yet since no figures are available on the expected electricity consumption. Therefore, after 2030, the 2030 diesel consumption value is assumed.

3.4.3. Results

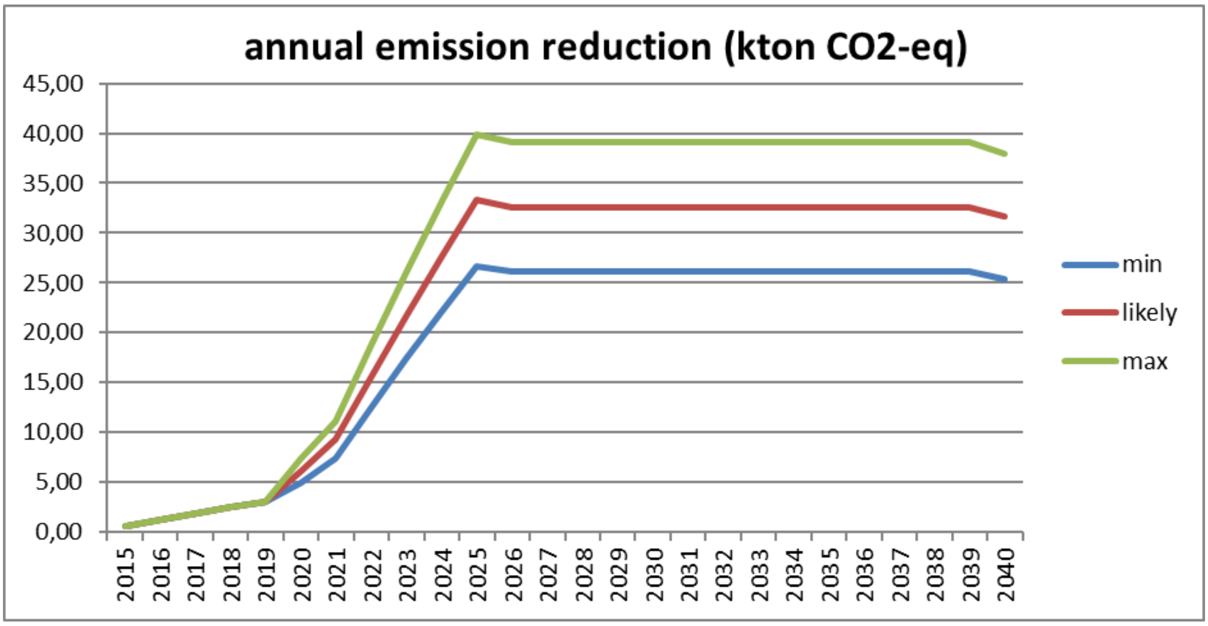


Figure 3: Estimated CO2 emission reductions due to energy savings per passenger-km by SNCB

Three scenarios are given: the likely scenario, based on the data provided by NMBS/SNCB, a minimum scenario, if only 80% of these reductions are achieved, and a maximum scenario, when 120% of the target reductions are attained.

We see that CO_2 emission reductions of up to 33.3 ktons can be achieved by 2025 for the likely scenario, thanks to these energy saving efforts.

3.4.4. References

- NMBS/SNCB data provided by Charlotte Dekeyser
- Passenger-km 2015-2018, personal communication FOD Mobility.
- https://mobilit.belgium.be/sites/default/files/kerncijfers_mobiliteit_2017.pdf
- Vooruitzichten van de transportvraag in België tegen 2040. Federaal Planbureau, januari 2019.
- The emission factors for electricity production used are detailed in section 3.1.
- Elektrificatie van het Belgische spoorwegnet of het gebruik van andere duurzamere vervoerswijzen om de dieseltractie te vervangen, TML Rapport voor: FOD Mobiliteit en Vervoer, 12/2020. https://mobilit.belgium.be/nl/nieuws/nieuwsberichten/2021/elektrificatie_van_het_belgische_spoorwegnet_het_gebruik_van_andere

3.5. APP-T04: Reduction non-traction energy use of railways

3.5.1. Description of the PAM

A. NMBS/SNCB

Between 2016 and 2020, the NMBS/SNCB group has reached a 13 % reduction of energy consumption for non-traction activities. This means that the goal of seven percent of energy consumption reduction for the period 2014-2020 was reached and even surpassed by 6 %. The main actions implemented to reach this goal were the following:

- Renewal and modernization of lighting installation systems for railway stations, offices, and other building services
- Continuation of the renewal of heating systems in buildings
- Replacement of old production facilities with more energy efficient one
- Restoration of existing buildings (isolation. etc.)

This PAM results in a reduction of emissions in both ETS and non-ETS sector.

B. Infrabel

During the last years, Infrabel has effectuated various efforts to decrease the energy consumption of owned buildings and is currently constructing new buildings to move offices from rented space towards owned space. The new buildings are planned to respect current energy performance standards and air temperature will be mainly regulated by heat pumps. The aim is to effectuate a fuel switch towards electricity and to stop using heating oil by 2030.

Infrabel is also shifting its carpark towards electric vehicles and is installing charging stations in owned buildings. Consequently, Infrabel's electricity consumption is expected to increase.

3.5.2. Methodology and assumptions

The estimation of NMBS/SNCB was done based on the submitted data. For future evolution, the minimum scenario assumes no further improvements. The maximum scenario assumes a careful estimation of 1% additional energy savings each year and the likely scenario is an average between both.

Again, we cannot make many comments as the provided information is very limited. However, we made an estimation based on the data transmitted from NMBS/SNCB for the years 2016 and 2020 (Table 12) and contrasted assumptions regarding the future energy consumption.

Energy vectors	GWh (final energy)	GWh (final energy)
	2016	2020
Natural gas	123.1	107.6
Heating oil	27.8	15.2
electricity	104.7	94.53
« green electricity »	0.1	5.07

Table 12: Data on energy consumption for non-traction activities

The estimation concerning Infrabel was based on submitted data concerning energy consumption of owned buildings and rented space since 2016 and projections until 2040 were used:

Energy vector	Unit	2016	2017	2018	2019
Natural gas	MWh	18 390	18 881	19 935	19 937
Heating oil	1000 liter	524	541	335	285

Electricity consumption	MWh	17 528	17 178	16 389	15 600

Table 13: Energy consumption of buildings owned by Infrabel

Energy vector	Unit	2018	2019
Natural gas	MWh	7 235	7 923
Heating oil	1000 liter	123	121
Electricity consumption	MWh	7 555	8 235

Table 14: Energy consumption of working space rented by Infrabel

The reductions were calculated using:

$$Emission\ Reduction = \left(\sum_{i} ER_i \cdot EF_i\right) AF¶$$

Where:¶

ER:·Energy·consumption·reduction·¶
EF:·emissions·factor·(ton·CO2eq/MWh)¶
I=·electricity,·gas,·heating·oil¶
AF:·Allocation·factor·(to·the·federal·measure)·(%)¶

We then made an estimation of future energy consumption for non-traction activities based on the following assumptions (NMBS/SNCB):

- Share in heating

To assess the emission reduction linked to a reduction of energy consumption for heating, it is primordial to identify the share in heating between heating oil and natural gas as their emission factors are different. The share in heating between heating oil and natural was calculated through a linear projection of data available for 2007-2012 and the years 2016 and 2020. The results of this calculation are presented in the table below.

Year	Share in heating	
	Heating oil	Natural gas
2005	39%	61%
2006	NA	NA
2007	37%	63%
2008	34%	66%
2009	30%	70%
2010	29%	71%
2011	32%	68%
2012	26%	74%
2013	24%	76%
2014	22%	78%
2015	20%	80%
2016	18%	82%
2017	17%	83%
2018	15%	85%
2019	14%	86%
2020	12%	88%

Table 15: Share in heating between heating oil and natural gas

- The projections of the energy consumption by buildings owned by Infrabel, the objectives submitted by Infrabel were used:

Energy vector	Unit	2025	2030	2035	2040
Natural gas	MWh	24 315	24 902	24 902	24 902
Heating oil	1000 l	138	0	0	0
Electricity consumption	MWh	16 769	18 355	20 883	22 103
Of which charging electric vehicles and tools	*MWh*	*145*	*1.536*	*4.063*	*5.284*

Table 16: Projected energy consumption and share in energy type for Infrabel

Energy vector	Unit	2025	2030	2035	2040
Natural gas	MWh	5 173	0	0	0
Heating oil	1000 l	80	0	0	0
Electricity consumption	MWh	8 235	8 235	8 235	8 235

Table 17: Projected energy consumption of space rented by Infrabel

- The electricity consumption supposed to be consumed by electric cars has been subtracted from the total consumption for the calculation of the CO_2 emission reductions
  - *Emission factors*

    As there is no definition of the direct and indirect impacts considered in the emissions factors used by the NMBS/SNCB, we decided to use the emissions factors commonly used in the past estimations of climate federal PAMs for heating oil and natural gas (VITO-ECONOTEC, 2015). With regards to electricity, we used the Belgian emission factor as explained in section 3.1. Table 18 below presents a comparison of emission factors used in the NMBS/SNCB estimations and in our update. We are aware, that NMBS/SNCB and Infrabel use green electricity also in buildings and this fraction has been considered but does not change the average emission factor in a significant way.

	Emission Factor (kg/kWh)		
	heating oil	natural gas	electricity
Our estimation	0.27	0.20	0.38[12]

Table 18: Emission factors

  - *Energy consumption reduction*

    As the energy consumption reduction is not easy to estimate without more precise information on the means implemented to allow for emissions reductions, we propose estimating three scenarios with contrasted assumptions:

    1. The maximum scenario

    For the maximum scenario, we allowed for an annual reduction of 1% of energy consumption from 2020 onwards. We assumed a linear reduction and we allocated this consumption reduction to both heating and electricity, based on their past share of energy consumption. In other words, we assumed that the total energy reduction was allocated following the proportion of heating and electricity in 2014 to 2020 into the total energy consumption for non-traction activities (see Table 19 below). For Infrabel, the Infrabel projection has been used as maximum and as likely scenario.

[12] The electricity EF evolves over time as detailed in section **Error! Reference source not found.**.

Year	Energy consumption (non-traction) (GWh)		
	heating	electricity	Share heating (%)
2014	149	114	57%
2015	148	112	57%
2016	151	105	59%
2017	144	104	58%
2018	137	103	57%
2019	130	101	56%
2020	123	100	55%

Table 19: Calculation of an allocation coefficient of energy consumption reduction between heating and electricity

2. **The minimum scenario**

For the minimum scenario, we assumed that no additional reduction in energy consumption was possible for electricity. Indeed, new technologies and new devices (information panel, security camera, etc.) need higher electricity consumption. We kept the energy consumption reduction for heating equal to the one calculated for the maximum scenario.

3. **The likely scenario**

This scenario corresponds to the mean between the maximum and minimum scenario results for NMBS/SNCB. For Infrabel, the projected energy consumptions are considered as likely scenario.

3.5.3. Results

A. NMBS/SNCB

The results are presented in the figure below. The maximum scenario shows a 16.22 ktCO_2 emissions reduction until 2050. Without the assumption that additional reductions in energy consumption can be made the minimum scenario corresponds to a reduction of 12.04 ktCO_2 emitted. Therefore, the emission reduction permitted by the likely scenario is 14.13 ktCO_2. The distinction between ETS and non-ETS emissions is presented in Figure 4:

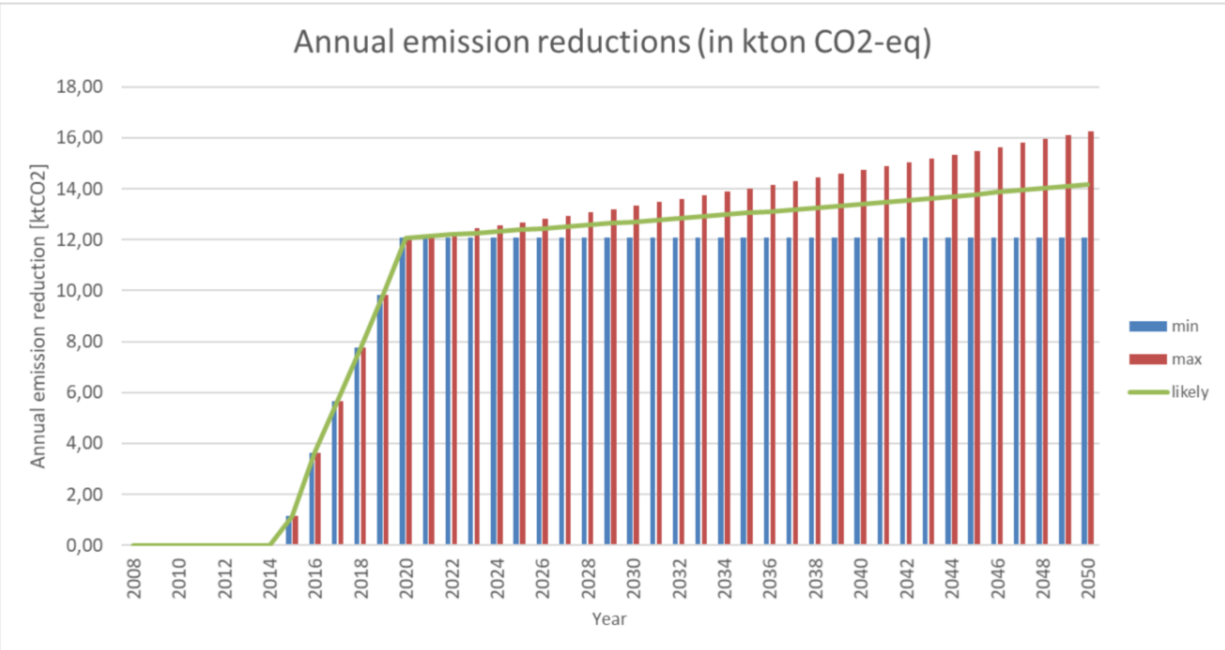


Figure 4: Total Federal Emission reductions by NMBS/SNCB (kton CO2) per scenario (minimum, maximum and likely)

Year	Federal Emission Reduction ETS (kton CO_2)			Federal Emission Reduction non-ETS (kton CO_2)		
	min	max	likely	min	max	likely
2021	0.00	0.00	0.00	0.00	0.00	0.00
2022	0.00	0.00	0.00	0.00	0.00	0.00
2023	0.00	0.00	0.00	0.00	0.00	0.00
2024	0.00	0.00	0.00	0.00	0.00	0.00
2025	0.00	0.00	0.00	0.00	0.00	0.00
2026	0.00	0.00	0.00	0.00	0.00	0.00
2027	0.00	0.00	0.00	0.00	0.00	0.00
2028	0.76	0.76	0.76	0.38	0.38	0.38
2029	3.51	3.51	3.51	0.13	0.13	0.13
2030	3.91	3.91	3.91	1.74	1.74	1.74
2035	4.38	4.38	4.38	3.36	3.36	3.36
2036	4.86	4.86	4.86	4.97	4.97	4.97
2037	5.49	5.49	5.49	6.58	6.58	6.58
2038	5.49	5.54	5.51	6.58	6.65	6.62
2039	5.49	5.60	5.54	6.58	6.72	6.65
2040	5.49	5.65	5.57	6.58	6.78	6.68
2041	5.49	5.71	5.60	6.58	6.85	6.72
2042	5.49	5.77	5.63	6.58	6.92	6.75
2043	5.49	5.82	5.66	6.58	6.99	6.79
2044	5.49	5.88	5.69	6.58	7.06	6.82
2045	5.49	5.94	5.71	6.58	7.13	6.86
2046	5.49	6.00	5.74	6.58	7.20	6.89
2047	5.49	6.06	5.77	6.58	7.27	6.93
2048	5.49	6.12	5.80	6.58	7.35	6.97
2049	5.49	6.18	5.84	6.58	7.42	7.00
2050	5.49	6.24	5.87	6.58	7.49	7.04

Table 20: Results by ETS and non-ETS emission reduction

B. Infrabel

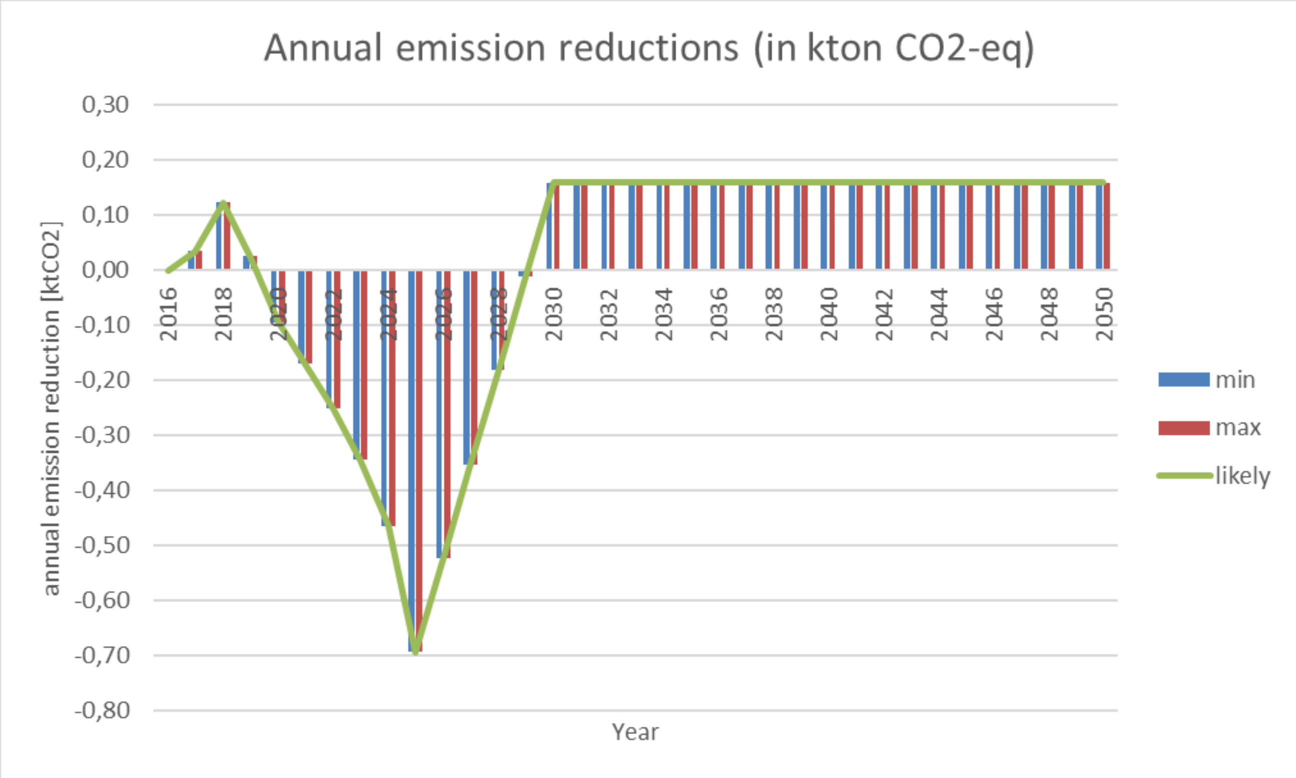


Figure 5: Total federal emission reduction of buildings owned by Infrabel

For Infrabel, the submitted data have been used as minimum, maximum, and likely scenario. The efforts made in the previous years are visible in terms of emission reduction with a maximum reduction of 0.14 kton CO_2 eq in 2018. After a transition period, where oil is still used, the emissions reductions stabilize at 0.16 kton CO_2.

3.5.4. Discussion

A. NMBS/SNCB

As the information regarding this PAM is limited, it is difficult to provide a more detailed critical analysis. However, with two contrasted sets of assumptions regarding the evolution of the energy consumption in non-traction activities of the NMBS/SNCB, we evaluated a range of emissions reductions of 10.67 ktCO_2 – 12.39 ktCO_2. To discuss this evaluation in more details, it should be interesting to identify and discuss if the means implemented at the NMBS/SNCB will permit these energy reductions. Also, the share of green energy has increased from nearly zero to more than five percent over the last four years and is susceptible to increase further.

B. Infrabel

The building situation at Infrabel is complicated as a part of their office space is situated in rented buildings. Fortunately, the energy consumption of the rented space could be considered to calculate the global energy consumption from Infrabel. Infrabel has started a campaign to reduce the energy consumption of owned buildings that is clearly visible in the consumption data between 2016 and 2018.

However, the projected overall energy consumptions between 2020 and 2025 display an increase in gas consumption while the projected electricity consumption keeps almost stable. The CO_2 emissions related to this increase in gas consumption are higher than the reduction due to the expected reductions of burning heating oil. Between 2030 and 2050, all consumption data are expected to keep stable.

As Infrabel is executing a fuel switch from oil towards electricity, this calculation is strongly impacted by the emission factor of electricity. Infrabel plans to consume as much electricity as possible by owned PV panels.

3.6. EC-A05 : Ecodesign/labelling

3.6.1. Description

The Federal government supports initiatives to assess the effectiveness of labels to inform consumers correctly. Uniformization of information on energy labels was a priority under the former Whatelet government (http://wathelet.belgium.be/nl/bevoegdheden/leefmilieu/). It is also important to mention here that there are EU labels containing information on energy efficiency for several important consumer goods.

Although not specifically included in the description of this PAM in the National Climate Plan, there is also a clear overlap with the Ecodesign directive (and its implementing measures). The responsible authority for preparing and implementing an integrated policy to promote sustainable products and consumption is the Federal Policy Division of Products and Chemicals. Among the tasks of this division is the maximisation of the implementation of the Ecodesign directive.

The specific objective of this PAM is therefore to reduce the energy consumption from appliances using fuel or electricity as covered by the EU Ecodesign Directive. The EU Ecodesign Directive establishes a "*framework under which manufacturers of energy-using products are obliged to reduce the energy consumption and other negative environmental impacts occurring throughout the product life cycle*"[13]. This means that the Ecodesign Directive requires new products to be more energy efficient, and due to the turnover of the fleet of products this gradually improves the energy efficiency of the appliances in the EU. In this section, we analyzed the impacts of implementing the Directive Ecodesign on all fossil fuel- and electricity fueled products covered by the Ecodesign Directive, including also energy labelling. This results in a reduction of emissions in both ETS and non-ETS sectors.

3.6.2. Methodology

Previously, to assess the impact of this policy, an EU wide study of energy savings achieved with the Ecodesign Directive (VHK. 2016) has been used. To update the assessment of the impact of the policy in Belgium, an updated version of this study is used (VHK, 2020). The scope of the study includes the impact of ecodesign-, labelling- voluntary agreement-, and (past- energy star measures[14]). The study is updated following Ecodesign review studies, new product groups. Compared to previous editions, it takes into account only the data on products for which a final regulation has been published, with the exception of standard air compressors. It provides energy savings for specific products and appliance types at EU28 level. A BAU (Business As Usual) scenario and an ECO scenario are developed, representing the situation without and with the measures enforced by the Ecodesign Directive. The difference between both is thus representative for the impact of the measures under the Ecodesign requirements.[15,16] The study covers 41 product groups with 237 base case products. The study takes into account the 'noncompliance' to the Ecodesign Directive, with a first estimate of the savings due to non-compliant products.

A. BAU scenario

The BAU scenario (without Ecodesign & energylabelling measures) it is derived from extrapolating historical trends at the time of the first preparatory study analysis, including ongoing market trends in energy

---

[13] https://www.eceee.org/ecodesign/process/

[14] see VHK, 2020 for more information

[15] VHK, 2020, p. 6.

[16] EIA now attempts to take into account, as far as available information allows, differences between the preferred policy option of the impact assessment and the final published regulation; - EIA does not take into account new proposed measures (in review studies or (draft) impact assessments) that have not been finalized yet; - EIA now includes a reporting on the reduction of savings due to non-compliance; - EIA does no longer report data on product groups / operational modes for which no Ecodesign or Energy Labelling regulation exists. (VHK, 2020, p. 7)

efficiency improvement and emissions abatement (VHK, 2020). This applies mainly to the future years, while historical years in the model are based mostly on actual data (e.g. on the stock, load and energy consumption of products).

B. PAM scenario

For the ECO scenario, the measures prescribed in the Ecodesign, Energy labelling, Energy Star and Tyre labelling impact is modelled. The ECO scenario seeks to reflect the final published regulations (VHK, 2020). In that sense, product groups (or usage modes) for which no final regulation has been published have been removed. Data on new measures are inserted when they have been finally decided[17]. After 2030, the scenarios assume that no further legislation and additional measures taken for new products, will be updated. The consequence is that the effect of measures from 2030-2050 diminishes or tend to flatten (VHK, 2020).

C. Calculation method

For the calculation of the energy consumption in the different scenarios, the stock and the sales of the different products are modelled. This is combined with the load of each of these appliances and the modelling of the energy efficiency (the ratio between energy input and output, or just the amount of energy use per unit of time), leading to the overall energy consumption per unit of time (here expressed per year). Implicitly all these parameters have their uncertainties and many include assumptions (for instance the future estimation of fuel prices, stock and load of specific appliances, etc.).

For the assessment of this PAM, we directly use the modelled energy consumption from the Ecodesign Impact Accounting study for both the BAU and ECO scenarios. For more details on the scenarios we refer to VHK (2020). In this study, this impact is only available for the EU as a whole, as no country specific information is available from this study. Therefore, the savings achieved have been downscaled from EU28 level to Belgium, using proxy parameters such as GDP, number of households and final electricity consumption. For heating appliances, a correction for heating degree days was made, noting that the demand for heating in Belgium is different from other European countries under different climate conditions.

The emission reduction is calculated with the following formula:

$$\boldsymbol{ER_{FED} = AF \times P \times EF}$$

With:

ER_{FED}	Federal emission reduction (kton CO_2-eq)
AF	Allocation factor (%)
P	Electricity production (MWh)
EF	Emission factor (kton CO_2-eq/MWh)

$$\boldsymbol{ER_{FED} = AF \times ER_{TOT}}$$

$$\boldsymbol{ER_{FED} = AF \times \textstyle\sum_i (ES_{BEL.\,i} \times EF)}$$

$$\boldsymbol{ER_{FED} = AF \times \textstyle\sum_i (ES_{EU.\,i} \times SF_i \times SF_{HDD} \times EF)}$$

With:

[17] E.g. positive vote from the regulatory Committee. (VHK, 2020)

ER_{FED}	Federal emission reduction (kton CO_2-eq)
ER_{TOT}	Total emission reduction (kton CO_2-eq)
AF	Allocation factor (%)
ES_{BEL}	Energy savings achieved in Belgium
EF	Emission factor
ES_{EU}	Energy savings achieved in EU
SF	Scaling factor

- The allocation factor is 100%. There are regional subsidies for energy efficient refrigerators and dryers, but these are only for a specific target group (vulnerable households).
- The energy savings achieved in Europe (EU28) are taken from the study Ecodesign Impact Accounting, status 2019 prepared by VHK Consultants for EU DG Energy (2020)
- The scaling factor to go from EU28 to Belgium is calculated for each technology based on the EU wide impact and an appropriate scaling factor. The scaling factor has been calculated basedon either number of households, GDP, final electricity consumption and corrected for heatingdegree days in specific cases.

The product categories included in this assessment are listed in Table 5. It should be noted that the scope of EC-A05 has changed in comparison with previous assessment (VITO/Econotec 2015), and the assessment made in 2017. Compared to the VITO/Econotec (2015) estimation, it covers more appliances, and both electricity- and fossil fuel fired appliances were included in the 2017 study. This revised assessment of 2021 includes new lots. The traffic light system reports the changes made compared to the previous assessment.

Application	Fuel	Comment BAU scenario (raw data until 2035)	Comment ECO scenario (raw data until 2035)	2035-2050
Total WH dedicated Water heater	electricity	Unchanged values compared to previous study until 2035	Unchanged values compared to previous study until 2035	New data
Total WH dedicated Water heater	fossil	Unchanged values compared to previous study until 2035	Unchanged values compared to previous study until 2035	New data
Total CH central Heating combi. water heat	electricity	Unchanged values compared to previous study until 2035	Unchanged values compared to previous study until 2035	New data
Total CH central Heating combi. water heat	fossil	Unchanged values compared to previous study until 2035	Unchanged values compared to previous study until 2035	New data
Total CH central Heating boiler. space heat	electricity	Unchanged values compared to previous study until 2035	Unchanged values compared to previous study until 2035	New data
Total CH central Heating boiler. space heat	fossil	Unchanged values compared to previous study until 2035	Values changed compared to previous study until 2035	New data

Total solid fuel boiler	electricity	Unchanged values compared to previous study until 2035	Unchanged values compared to previous study until 2035	New data
Total solid fuel boiler	coal	Unchanged values compared to previous study until 2035	Values changed compared to previous study until 2035	New data
Sub-total AHC central air cooling	electricity	Value change for the year 2035 only.	Value change for the year 2035 only.	New data
Sub-total AHC central air heating	electricity	Unchanged values compared to previous study until 2035	Values changed compared to previous study until 2035	New data
Sub-total AHC central air heating	fossil	Unchanged values compared to previous study until 2035	Values changed compared to previous study until 2035	New data
LH total	electricity	Unchanged values compared to previous study until 2035	Values changed compared to previous study until 2035	New data
LH total	coal	Unchanged values compared to previous study until 2035	Values changed compared to previous study until 2035	New data
LH total	oil	Unchanged values compared to previous study until 2035	Values changed compared to previous study until 2035	New data
LH total	gas	Changed compared to previous study. Takes into account cooker. open fire gas. closed fire gas and tube heaters)	Values changed compared to previous study until 2035	New data
Total RAC room air conditioner	electricity	Unchanged values compared to previous study until 2035	Values changed compared to previous study until 2035	New data
Total VU (electricity only)	electricity	Unchanged values compared to previous study until 2035	Unchanged values compared to previous study until 2035	New data
Total VU (heat savings by ventilation)	fossil	Unchanged values compared to previous study until 2035	Unchanged values compared to previous study until 2035	New data
Total lighting (incl. standby)	electricity	Values changed	Values changed compared to previous study until 2035	New data

DP total electronic displays	electricity	Values charged	Values changed compared to previous study until 2035	New data
Total STB set top boxes (complex & simple)	Electricity	Values changed	Values changed compared to previous study until 2035	New data
Total VIDEO (games)	Electricity	Values changed	Values changed compared to previous study until 2035	New data
Total ES enterprise servers	electricity	Values changed	Values changed compared to previous study until 2035	New data
DP TV total on mode + standby	Electricity	NEW		New data
DP monitor total	Electricity	NEW		New data
DP signage total	electricity	NEW		New data

DS data storage products total	Electricity	NEW		New data
Total PC electricity	electricity	Unchanged values compared to previous study until 2035	Unchanged values compared to previous study until 2035	New data
Total imaging equipment. electricity	Electricity	Values changed	Values changed compared to previous study until 2035	New data
Total SB (networked) sandby (excl. double)	Electricity	Values changed	Values changed compared to previous study until 2035	New data
EPS double counted substracted	Electricity	NEW		New data
Total BC battery charged devices	Electricity	removed		New data
Total UPS – uninterrupted power supplies	Electricity	removed		New data
Total RF Household Refrigerators & freezers	Electricity	Unchanged values compared to previous study until 2035	Values changed compared to previous study until 2035	New data
Total CF commercial refrigeration	electricity	Values changed	Values changed compared to previous study until 2035	New data
PF storage cabinets all types	electricity	Unchanged values compared to previous study until 2035	Values changed compared to previous study until 2035	New data
PF process chiller all MT&LT	electricity	Unchanged values compared to previous study until 2035	Values changed compared to previous study until 2035	New data
PF condensing unit. all MT& LT	electricity	Values changed	Values changed compared to previous study until 2035	New data
Total CA cooking appliances	Electricity	Values changed	Values changed compared to previous study until 2035	New data
Total CA cooking appliances	Gas	Unchanged values compared to previous study until 2035	Unchanged values compared to previous study until 2035	New data

Total CM household coffee makers	Electricity	removed		New data
Total WM household washing (washing machines and dryers)	Electricity	Values changed because it takes into account dryers	Values changed compared to previous study until 2035	New data
Total DW household dishwasher	electricity	Unchanged values compared to previous study until 2035	Unchanged values compared to previous study until 2035	New data
Total LD household laundry dryer	electricity	Unchanged values compared to previous study until 2035	Unchanged values compared to previous study until 2035	New data
Total VC Vacuum Cleaner	electricity	Unchanged values compared to previous study until 2035	Unchanged values compared to previous study until 2035	New data
Total FAN industrial (excl. box & roof fans)	electricity	Unchanged values compared to previous study until 2035	Unchanged values compared to previous study until 2035	New data
Total MT elec. Motors LV 0.12-1000 kW	Electricity	Values changes because previously Motors 0.75-375 kW	Values changed compared to previous study until 2035	New data
Total WP water pumps	electricity	Unchanged values compared to previous study until 2035	Values changed compared to previous study until 2035	New data
Total CP standard air compressors.	electricity	Unchanged values compared to previous study until 2035	Values changed compared to previous study until 2035	New data
Total WE Welding equipment	Electricity	NEW		New data
Total TRAFO utility transformers	Electricity	NEW		New data
Total energy sector	electricity	Unchanged values compared to previous study until 2035	Values changed compared to previous study until 2035	New data
Tyres replacement & OEM tyres (cars. vans. truck/busses)	On-road fuels	Values changed because takes into account OEM tyres	Values changed compared to previous study until 2035	New data

Table 21: Product categories included for PAM EC-A05 and the changes made compared to the previous assessment

D.Non- compliance scenario

The European study assessed the impact of the Ecodesign Directive based on preparatory and reviewstudies as well as impact assessment. Those studies do not take into account the possibility that a share of product on the market might be non-compliant with the regulations due to limitations in the market surveillance. In that sense, a first estimate of the possible reduction of reported savings due to non -compliance (NC) is performed. The results are provided only for the total over all product groups. The European Court of Auditors refers to a 10% of energy savings lost due to non-compliance. Although this value can show limitations (see VKH 2020 for more information), 10% is the value applied in this study (VKH, 2020).

3.6.3. Main assumptions

A General assumptions

Allocation factor

This PAM is about the impact of the European Ecodesign Directive for Belgium, the impact of this measure is completely federal. Therefore, the allocation factor is set to 100%.

Emission factors

Electricity: it is assumed that the electricity would not have been produced in a CCGT power plant (see section 3.1). It is also possible that the reduction of electricity production takes place in coal fired power plants (with a higher emission factor) or in nuclear power plants (with a lower emission factor).

When electricity transport and distribution losses (4.5%) are also taken into account, then the emission factor of electricity consumption is 381 g CO_2/kWh in 2021 as the loss factor is applied to the electricity EF. This last factor, which evolves over time, has been adopted for this study.

Road vehicles: the average value of diesel and gasoline has been assumed. Despite nowadays most vehicles in Belgium drive on diesel, this may change in the future. It should be noted that once non-fossil fuel fired vehicles (e.g. electric) are being introduced, the effective emission factor (representing the entire fleet) reduces and the impact of this PAM for vehicles will be lower.

Fossil fuels: for coal an emission factor of 333.8 kg CO_2/TWh has been used. For oil this factor amounted 264 kg CO_2/TWh and for natural gas 201 kg CO_2/TWh. Where fossil is mentioned as fuel, the assumption is used that 80% is natural gas and 20% oil, which yields an emission factor of 213.6 kg CO_2/TWh.

Scaling from EU to BE situation

To translate the EU level results in the VHK study to Belgium, a downscaling is needed. This is done using proxy parameters such as GDP, number of households, final electricity consumption, etc. To derive these proxies, projections for parameters for the future years have been used, based on statistical information, assumptions and extrapolations.

Scaling factor for heating degree days (HDD)

Based on European data available from the EEA and Eurostat, an assessment of historical heating degree days at EU level and at individual country level has been made. It was found that despite year- to-year variation of the ratio between HDD in Belgium and the EU as a whole, the ratio there was no trend. The average ratio over all available years was used, which was calculated to be BE / EU = 1 /1.137 (thus the demand for heating in Belgium in terms of HDD would be lower than the European average). This scaling is applied only for heating devices, as all other appliances are assumed to be largely independent of climatological conditions.

B. BAU scenario assumptions

In the BAU scenario, it is assumed that no additional policies are implemented with regard to the present day. This means that the BAU scenario reflects the situation without Ecodesign in place. For more information, see VHK study (VHK, 2020).

C. PAM scenario assumptions

There are no specific assumptions for the PAM scenario, for more information see VHK study (VHK, 2020).

D. Non-compliance scenario

Assumption of a 10% loss of energy savings due to non-compliance, constant over the years (VHK, 2020).

3.6.4. Data sources

- VHK. Ecodesign Impact Accounting. Status report. June 2020. Report for EU DG Energy.
- VHK. Ecodesign Impact Accounting. Status January 2016. Report for EU DG Energy.
- Vito/Econotec, 2015. Evaluation of the impact of policy instruments and measures implemented in the context of the Federal climate policy. March 2015.

For the proxy data. Table 6 presents the data used and their source.

Proxy parameter	Source Belgium	Source EU28
POP (population)	Belgian Federal Statistical Agency (historical data and projections) https://statbel.fgov.be/fr/themes/population/perspectives-de-la-population#panel-14	Eurostat (historical data and projections)until 2020 http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=proj_15npms&lang=en For consistency with the assumptions on the EU28 level, the population projectiondisregard the Brexit in place since 1st January 2021, and assumes an EU 28 population projection. (VHK, 2020).
		Eurostat population projections (2019-2100).

HH (households)	Belgium Federal Statistics Agency - ménages privés en Belgiques au 1er janvier 1992-2071 (https://statbel.fgov.be/fr/themes/population/perspectives-de-la-population#panel-12)	Eurostat for historical years (http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=lfst_hhnhtych&lang=en). after 2019 no data available. For projections. the trend in the number of people per household from Belgium has been extrapolated to Europe (using population statistics).
GDP	Eurostat http://ec.europa.eu/eurostat/data/database	Eurostat. IIASA GAINS model GDP projections for future years (latest projections using scenario WPE_2014_CLE) calculated as relative change with respect to latest Eurostat year. Linear extrapolation beyond 2030. http://ec.europa.eu/eurostat/data/database Historical data (2011-2019): Eurostat - Data Explorer (europa.eu)
FINELEC (final electricity consumption)	Eurostat energy statistics. linear extrapolation for future years http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_100a&lang=en	Eurostat energy statistics, linear extrapolation for future years http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_100a&lang=en
VKM (vehicle kilometers)	Vehicle kilometers in future years by vehicle type: TREMOVE model v3.3.2 (TML) http://www.tmleuven.be/methode/tremove/home.htm	Vehicle kilometers in future years by vehicle type: TREMOVE model v3.3.2 (TML) http://www.tmleuven.be/methode/tremove/home.htm

Table 22: Description of data sources

3.6.5. Results

The calculated reduction using this methodology has been interpreted and presented as the maximum reduction. Main reasons are:

- Uncertainty in the calculations (both in the EU study itself and methodology of downscaling to Belgium presented in this sheet)
- Possibility that the Ecodesign Directive does not result in the projected reductions (non-performing to some extent)
- In New Member States (East Europe) the average installation age of the current stock is likelyto be older. therefore the potential for reduction is likely to be higher in these countries

For specific products, other technology developments or mitigation measures may be taken which take away part of the reduction potential of the Ecodesign Directive. An example is the use of more efficient tyres which reduces fuel consumption in cars, but the CO_2 reduction associated with that is likely to change in future years considering the ongoing developments in (a.o.) electric vehicles.

Given the main uncertainties described above, the exact quantification of the reduction that will be achieved through implementation of the Ecodesign Directive is rather uncertain. Since most of the uncertainties point towards a possible overestimation of the projected energy savings for Belgium, we have chosen to interpret the calculated reduction as the upper limit. The lower limit has been estimated at 50% of the calculated reduction, which is an expert judgement. For the likely value, the average between lower and upper estimate has been assumed (75% of the calculated reduction). It should be noted that the choice of 50% and 75% as the minimum and likely emission reduction are an expert judgement, and these values are debatable.

Limitations include the difficulty in retrieving the information necessary to update the study and solving inconsistencies between the new information and the data already present. The study covers EU28, and include therefore the UK, which will be removed in future studies (VHK, 2020). The proxy used to estimate the population at the horizon 2050 is based on the EU28 and disregard the Brexit for data consistency.

The results are shown in Table 23 and Figure 6. This PAM is expected to result in a reduction of 9150 kton CO_2-eq by 2025, and 11500 kton CO_2-eq by 2035. The effects of non-compliance estimates a reduction of emissions of 8200 ktonCO_2-eq by 2025, and 10400 kton CO_2-eq by 2035.

Year	Minimum	Maximum	Likely			Non compliance		
			Total	ETS	Non-ETS	Total	ETS	Non-ETS
2008	114	229	171	353	-182	154	318	-164
2009	350	701	526	498	28	473	448	25
2010	581	1 162	871	634	238	784	570	214
2011	890	1 780	1 335	839	496	1 201	755	446
2012	1 227	2 453	1 840	1 077	762	1 656	970	686
2013	1 570	3 140	2 355	1 323	1 032	2 119	1 191	928
2014	1 890	3 780	2 835	1 547	1 288	2 552	1 392	1 160
2015	2 198	4 396	3 297	1 759	1 538	2 967	1 583	1 384
2016	2 678	5 355	4 016	2 196	1 821	3 615	1 976	1 639
2017	3 140	6 280	4 710	2 616	2 094	4 239	2 354	1 885
2018	3 666	7 333	5 500	3 096	2 404	4 950	2 786	2 163
2019	4 138	8 275	6 206	3 525	2 682	5 586	3 172	2 414
2020	4 311	8 622	6 466	3 675	2 792	5 820	3 307	2 512
2021	4 715	9 430	7 073	4 007	3 066	6 365	3 606	2 759
2022	5 108	10 217	7 663	4 327	3 335	6 896	3 895	3 002
2023	5 434	10 869	8 152	4 544	3 608	7 336	4 089	3 247
2024	5 755	11 509	8 632	4 751	3 881	7 769	4 276	3 493
2025	6 099	12 198	9 149	4 976	4 172	8 234	4 479	3 755
2026	6 300	12 600	9 450	5 071	4 380	8 505	4 564	3 942
2027	6 550	13 101	9 826	5 253	4 573	8 843	4 727	4 116
2028	6 800	13 601	10 200	5 435	4 766	9 180	4 891	4 289
2029	7 054	14 109	10 582	5 621	4 961	9 524	5 059	4 465
2030	7 341	14 682	11 012	5 835	5 176	9 910	5 252	4 659

2031	7 358	14 716	11 037	5 837	5 200	9 933	5 253	4 680
2032	7 439	14 877	11 158	5 894	5 264	10 042	5 305	4 738
2033	7 520	15 039	11 279	5 951	5 328	10 151	5 356	4 795
2034	7 601	15 202	11 401	6 009	5 392	10 261	5 408	4 853
2035	7 682	15 365	11 524	6 068	5 456	10 371	5 461	4 910
2036	7 672	15 345	11 508	6 033	5 476	10 358	5 430	4 928
2037	7 662	15 324	11 493	5 998	5 495	10 344	5 398	4 946
2038	7 652	15 304	11 478	5 964	5 515	10 330	5 367	4 963
2039	7 642	15 284	11 463	5 929	5 534	10 316	5 336	4 981
2040	7 500	15 001	11 251	5 697	5 553	10 126	5 128	4 998
2041	7 468	14 936	11 202	5 656	5 546	10 082	5 090	4 992
2042	7 436	14 871	11 154	5 614	5 540	10 038	5 053	4 986
2043	7 403	14 806	11 105	5 572	5 533	9 994	5 015	4 979
2044	7 370	14 741	11 055	5 530	5 525	9 950	4 977	4 973
2045	7 337	14 674	11 006	5 488	5 518	9 905	4 939	4 966
2046	7 307	14 615	10 961	5 466	5 495	9 865	4 919	4 946
2047	7 277	14 555	10 916	5 444	5 472	9 824	4 900	4 925
2048	7 247	14 494	10 871	5 422	5 449	9 784	4 880	4 904
2049	7 217	14 434	10 825	5 400	5 425	9 743	4 860	4 883
2050	7 186	14 373	10 780	5 378	5 402	9 702	4 840	4 862

Table 23: Projected emission reductions from implementation of the Ecodesign Directive in Belgium (in kton CO_2-eq)

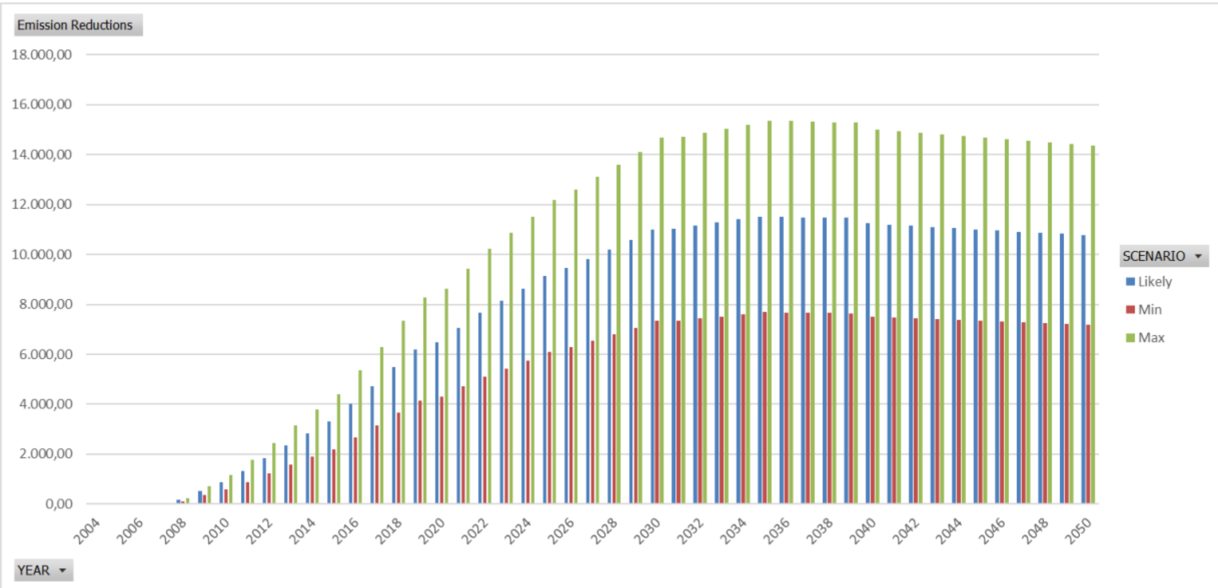


Figure 6: Annual emission reductions (minimum, maximum and likely scenarios)

3.6.6. Discussion

It is recognized that there are significant uncertainties with this approach. We have considered making an alternative bottom-up analysis for Belgium; however, this would require availability of detailed datasets on the stock, use and energy efficiency of all the different products. Unfortunately, this information was not available for this assessment.

The emission savings increase rapidly between 2008 and 2030, due to new legislation for new product lots and the sale of new, more efficient, appliances. In 2019, the latest GHG emission inventory year available, the emission savings from the eco-design directive correspond with 7% of CO_2 emissions in the sector 1.A. (fuel combustion activities including energy industries, industry and manufacturing, transport, buildings and other sectors). Our calculation thus suggests that without the eco-design directive, CO_2 emissions in 2019 would be 7% higher in the sector 1.A. The CO_2 emission savings from this measure increase to a maximum of 11 524 kton in 2035.

For emission savings in the ETS sector, the emission savings amount to 3 525 kton CO_2 in 2019, corresponding with 23% of emissions in the sector 1.A.1.a (public electricity and heat production) in 2019. Our calculation thus suggests that without the eco-design directive, CO_2 emissions in 2019 would be 23% higher in the sector 1.A.1a. This is a significant impact, but between 2008 and 2019, CO_2 emissions in the sector 1.A.1.a showed a substantial decrease of 5 167 kton in Belgium. The ETS CO_2 emission savings increase to a maximum of 6 068 kton in 2035.

3.6.7. References

- VHK. Ecodesign Impact Accounting. Status report. June 2020. Report for EU DG Energy. Retrieved from: https://www.vhk.nl/downloads/Reports/EIA/EIA%20Status%20Report%202019%20-%20VHK20201028.pdf
- VHK. Ecodesign Impact Accounting. Status January 2016. Report for EU DG Energy. https://ec.europa.eu/energy/sites/ener/files/documents/Ecodesign%20Impacts%20Accounting%20%20-%20status%20January%202016%20-%20Final-20160607%20-%20Npdf
- Vito/Econotec, 2015. Evaluation of the impact of policy instruments and measures implemented in the context of the Federal climate policy. March 2015.

3.7. EC-B01: Tax incentive to promote energy efficiency in households

3.7.1. Description

The objective of this PAM is to improve the energy efficiency of buildings. This results in a reduction of emissions in both ETS and non-ETS sectors.

Tax reductions and subsidies have been granted for part of the cost of investments aiming to increase energy efficiency in households (Vito/Econotec, 2015). This includes investments to improve insulation (floor, wall, roof and glazing), to install efficient installations (condensing boilers, heat pumps, PV, solar thermal, thermostats). From 2012 onwards, only roof insulations are subsidised. From 2015 onwards, regions are responsible for the measure.

3.7.2. Methodology

The emission reduction is calculated based on the equipment installed in households and the expected lower energy use of these appliances. The emission reduction is calculated for each year of the lifetime of an investment. Emission reductions are no longer calculated once the lifetime is over and the installation is removed or replaced.

A. BAU scenario

Within the Business-as-usual scenario, no new investments are done for insulation or for installing efficient heat/electricity systems.

B. PAM scenario

Within the PAM scenario, new investments are done for improving energy efficiency. All the investments from 2004 on are part of this scenario. After the expected lifetime of measures, it is assumed that the reduced CO_2 emissions are no longer a result of the tax incentives or subsidies from the federal government.

The BAU scenario does not consider that some people will improve energy efficiency in their house even if no tax reductions and subsidies are available (free rider effect), while the PAM scenario does not take a possible multiplier effect into account. It is assumed that the free rider effect and the multiplier effect will compensate each other.

The rebound effect is not included in the emission reduction calculation, but it probably influences the achieved emission reduction.

The emission reduction is calculated with the following formula:

$$\boldsymbol{ER_{FED}} = \sum_{\boldsymbol{i}} (\boldsymbol{AF_i} \times \boldsymbol{N_i} \times \boldsymbol{UER})$$

With:

ER_{FED}	Federal emission reduction (kton CO_2-eq)
AF_i	Allocation factor per type of investment (%)
N_i	Number of applications per type of investment
UER_i	Unit emission reduction per type of investment (kg CO_2) (unit energy saving * EF)

The emission reduction is calculated for each year of the lifetime of an investment. Emission reductions are no longer calculated once the lifetime is over and the installation is removed or replaced.

3.7.3. Main assumptions

A. BAU scenario assumptions

It is assumed that no new investments are done for insulation or for installing heat/electricity systems.

B. PAM scenario assumptions

Allocation factor

The allocation factor differs per investment. It has been calculated following the same methodology as Vito/Econotec (2015) based on the average investment cost of the technology and the maximum amount that can be reduced compared to the premiums of the different regions. From 2015 onwards, the regions will be responsible for this tax reduction and the allocation factor for the federal government for new tax reductions and subsidies will be 0%. The CO_2 emission reduction gained from measures before 2015 are still allocated to the federal government.

Unit energy savings

Table 24 shows the unit energy savings (in GJ per application per year) from Vito/Econotec (2015). The unit energy savings depend on the type of technology and the efficiency of the old and new situation. A more detailed description of the calculation of the unit energy savings is provided in Vito/Econotec (2015).

Year	Condensing boiler (GJ/unit)	Roof insulation (GJ/unit)	Heat pump (GJ/unit)	Double glazing (GJ/unit)	PV (kWh/unit)	Solar thermal (kWh/unit)	Wall insulation (GJ/unit)	Floor insulation (GJ/unit)	Thermostats (GJ/unit)	Passive house (kWh/unit)
2004	47.8	42.7	62.5	15.3	2 125	520	33.3	3.5	4.5	9 577
2005	47.8	38.1	62.5	14.5	2 125	516	34.4	3.5	4.5	9 577
2006	47.8	37.8	62.5	15.2	2 125	511	48.6	3.5	4.5	9 577
2007	47.8	37.0	62.5	16.0	2 125	506	34.3	3.5	4.5	9 577
2008	27.2	23.2	62.5	9.7	2 125	501	28.7	3.1	3.9	9 577
2009	27.2	23.1	62.5	8.7	2 125	496	27.8	3.1	3.9	9 577
2010	27.2	24.3	62.5	9.9	2 125	492	31.9	3.1	3.9	9 577
2011	27.2	24.3	62.5	9.9	2 125	488	31.9	3.1	3.9	9 577
2012	27.2	24.3	62.5	9.9	2 125	485	31.9	3.1	3.9	9 577
2013	27.2	24.3	62.5	9.9	2 125	482	31.9	3.1	3.9	9 577
2014	27.2	24.3	62.5	9.9	2 125	469	31.9	3.1	3.9	9 577
2015	27.2	24.3	62.5	9.9	2 125	465	31.9	3.1	3.9	9 577
2020	27.2	24.3	62.5	9.9	2 125	448	31.9	3.1	3.9	9 577
2025	27.2	24.3	62.5	9.9	2 125	432	31.9	3.1	3.9	9 577
2030	27.2	24.3	62.5	9.9	2 125	416	31.9	3.1	3.9	9 577
2035	27.2	24.3	62.5	9.9	2 125	400	31.9	3.1	3.9	9 577

Table 24: Unit energy savings per application (GJ/year)

The unit energy savings is comparable to key figures from other studies (see next paragraphs), and therefore the unit energy savings from Vito/Econotec (2015) has been used.

Energy reductions from insulation

SenterNovem (2007) and ECN (2012) provide several key figures for energy efficiency from insulation.

SenterNovem (2007) indicates a reduction of natural gas use of 4-27 m^3 per m^2 per year for roof insulation. 14-34 m^3 per m^2 per year for double glazing. 9-19 m^3 per m^2 per year for wall insulation and 3 m^3 per m^2 per year for floor insulation. ECN (2012) indicates a reduction of natural gas use of 13 m^3 per m^2 per year for roof insulation, 5-17 m^3 per m^2 per year for double glazing, 8-9 m^3 per m^2 per year for wall insulation and 2.5-2.8 m^3 per m^2 per year for floor insulation.

With an average size of 74 m^2 for roof and floor insulation, 15 m^2 for double glazing and 100 m^2 for wall insulation, this results in a reduction of energy consumption presented in Table 25.

	Vito/Econotec	SenterNovem. 2007	ECN. 2012
Roof insulation	23.1 - 42.7	9.4 - 63.2	30.4
Double glazing	8.7 - 15.3	6.6 - 16.1	2.4 - 8.1
Wall insulation	27.8 - 48.6	28.5 - 60.1	25.3 – 28.5
Floor insulation	3.1 - 3.5	7	5.9 – 6.6

Table 25: Reduction of energy consumption

The unit energy savings from Vito/Econotec (2015) are in the same order of magnitude as the energy reduction from SenterNovem (2007) and ECN (2012). Only for floor insulation, the energy reduction differs by a factor of two. The difference can be explained by the fact that the average heat loss through floors in the Netherlands is much higher than in Belgium (data from Entranze) and therefore the possible energy savings in Belgium is lower.

Therefore, we continued to use the unit energy savings from Vito/Econotec (2015) for all type of insulation.

Condensing boiler

Compared to SenterNovem, 2007: When a boiler is replaced by a condensing boiler, then the maximum reduction of energy consumption is 7-18% (depending on the old boiler used). In ECN (2012), the maximum reduction of energy consumption is 3-20%. In 2014, Belgium used 256 420 TJ for residential combustion (CRF tables from June 2016). Dividing this by 3 693 544 houses (http://statbel.fgov.be), results in an average 69.4 GJ per house. A reduction of 3-20% results in an energy reduction of 2.1-13.9 GJ per unit per year.

The unit energy reduction in the Vito/Econotec report (2015) is higher (27.2-47.8 GJ/unit) than the reduction calculated from the data from SenterNovem (2007) and from ECN (2012). This is mainly caused by the fact that in Belgium more fuels are used for residential heating and therefore a larger energy reduction can be achieved (data from Entranze). Therefore, we continued to use the unit energy savings from Vito/Econotec (2015) for the condensing boilers.

Heat pumps

The unit emission reduction for heat pumps has been taken from the VITO/Econotec (2015) report. This factor is based on an average capacity of 8 kW, 2000 full load hours and a COP of 3.5. Compared to the values found in other studies in literature, only the COP could be higher, which would mean a higher unit emission reduction. However, given that the average capacity and full load are typical values compared to other estimates in literature, there has been no reason to change to the Vito/Econotec (2015) estimate for the unit emission reduction for heat pumps.

PV

In Vito/Econotec (2015), the CO_2 emission reduction from PV is calculated with an average PV installation size of 2.5 kWp and an efficiency of 850 kWh/kWp. An installation size of 2.5 kWp equals approximately 10 solar panels (depending on the capacity of the solar panel).

Unit emission reduction (UER)

The unit emission reductions have been calculated by multiplying the unit energy savings with an emission factor. The emission factor depends on the type of fuel that is saved. For heat related investments (insulation, boilers), the emission factor varies between 60 kg CO_2/GJ and 65 kg CO_2/GJ, depending on the average fuel type saved (natural gas (55.8 kg CO_2/GJ) or and heating oil (73.3 kg CO_2/GJ)). The electricity emission factor (see section 3.1) is used for electricity related investments (PV).

Table 26 shows the unit emission reductions (in kg CO_2 per application per year) from Vito/Econotec (2015). These values have been used in the calculation of CO_2 emissions reduction from energy efficiency in households.

Year	Condensing boiler	Roof insulation	Heat pump	Double glazing	PV	Solar thermal	Wall insulation	Floor insulation	Thermostats	Passive house
2004	3 169	2 507	1 954	932	808	355	2 070	227	291	2 146
2005	3 169	2 242	1 954	886	808	353	2 144	227	291	2 146
2006	3 169	2 242	1 954	926	808	349	3 027	227	291	2 146
2007	3 169	2 174	1 954	973	808	345	2 133	227	291	2 146
2008	1 843	1 449	1 954	619	808	342	1 872	200	256	2 146
2009	1 843	1 439	1 954	554	808	339	1 813	200	256	2 146
2010	1 843	1 517	1 954	633	808	337	2 079	200	256	2 146
2011	1 843	1 517	1 954	633	808	334	2 079	200	256	2 146
2012	1 843	1 517	1 954	633	808	332	2 079	200	256	2 146
2013		1 517								
2014		1 517								

Table 26: Unit emission reductions per application (kg CO2/year)

A comparison of the unit emission reductions with other studies is difficult due to differences in the fuel mix in the BAU scenario. Therefore, only a comparison is made for the unit energy savings (see paragraph above). The unit energy savings are comparable to several other studies and the emission factors are in the range of emission factors of natural gas and heating oil. Therefore, we concluded that the unit emission reductions are applicable for estimating the emission reduction of energy efficiency investments in Belgium.

Lifetime of investments

The lifetime of investments is presented in Table 27. These are from EC, 2010.

Investment	Life expectancy
Condensing boiler	20 years
Roof insulation	25 years
Heat pump	25 years
Double glazing	30 years
PV	23 years
Solar thermal	20 years
Wall insulation	30 years
Floor insulation	25 years
Thermostats	10 years

Table 27: Expected lifetime for each investment (years)

Minimum and maximum scenario

The emission reduction is calculated using average values for number of applications and UERs. In Vito/Econotec (2015), the minimum and maximum emission reduction is calculated using a Monte Carlo analysis. The uncertainty range resulting from the Monte Carlo analysis in the Vito/Econotec report (2015) is presented in Table 28. The 95% uncertainty range has been used to calculate the minimum and maximum emission reduction.

Year	Mean emission reduction (kton CO_2eq)	Min emission reduction (kton CO_2eq)	Max emission reduction (kton CO_2eq)	95% uncertainty range (%)
2004	124	69	180	± 45%
2005	249	166	333	± 34%
2006	407	295	520	± 28%
2007	657	504	810	± 23%
2008	915	732	1 097	± 20%
2009	1 228	1 030	1 426	± 16%
2010	1 659	1 447	1 872	± 14%
2011	2 129	1 901	2 357	± 12%
2012	2 181	1 958	2 404	± 11%
2013	2 214	1 998	2 431	± 11%
2014	2 264	2 051	2 478	± 11%
2015	2 258	2 054	2 461	± 9%
2016	2 247	2 053	2 442	± 9%
2017	2 236	2 048	2 425	± 9%
2018	2 231	2 042	2 419	± 9%
2019	2 219	2 030	2 408	± 9%
2020	2 208	2 015	2 401	± 9%
2021	2 208	2 019	2 397	± 9%
2022	2 208	2 024	2 392	± 9%
2023	2 208	2 028	2 387	± 9%
2024	2 166	1 993	2 338	± 9%
2025	2 123	1 958	2 288	± 9%
2026	2 076	1 916	2 237	± 9%
2027	1 985	1 829	2 141	± 10%
2028	1 891	1 737	2 045	± 10%
2029	1 744	1 595	1 892	± 11%
2030	1 566	1 424	1 709	± 12%
2031	1 314	1 181	1 446	± 14%
2032	1 257	1 122	1 392	± 15%
2033	1 197	1 059	1 335	± 16%
2034	1 048	914	1 181	± 18%
2035	861	740	981	± 21%

Table 28: Emission reductions and uncertainty range

3.7.4. Data sources

Data sources for each indicator are presented in Table 29.

Indicators	Ex-ante values	Ex-post values
AF	See assumptions	See assumptions (0% from 2015)
Number of applications (N)	FPS Finance	n.a. (no new applications)
Emission factor (EF)	See assumptions	See assumptions

Table 29: Description of data sources

3.7.5. Results

From 2015 onwards, the regions are responsible for this tax reduction and the allocation factor for the federal government for new tax reductions and subsidies will be 0%. The CO_2 emission reduction gained from measures before 2015 are still allocated to the federal government.

After the expected lifetime of measures, it is assumed that the reduced CO_2 emissions are no longer a result of the tax incentives or subsidies from the federal government. Therefore, the annual emission reductions decrease from 2022 on. Figure 7 presents the minimum and maximum scenario for the annual CO_2 emission reductions.

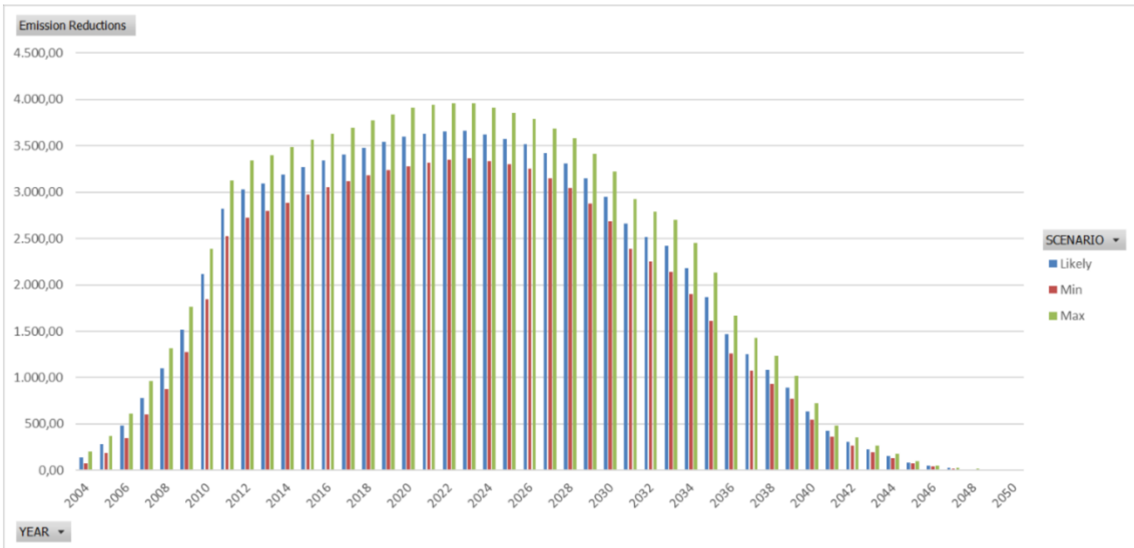


Figure 7: Annual emission reductions (minimum, maximum and likely scenarios)

3.7.6. Discussion

This emission calculation contains many variables and uncertainties. The main uncertainties in the emission reduction calculation include the emission reduction units and the average lifetime. The energy reduction units have been compared to energy reduction units in several other studies, which show similar values and therefore the average emission reduction is probably the most likely.

The possible largest variable that is not included in the emission reduction calculations is the rebound effect. Because the rebound effect is not taken into account, the calculated annual emission reduction could be an overestimation.

3.7.7. References

- Vito/Econotec, 2015. Evaluation of the impact of policy instruments and measures implemented in the context of the Federal climate policy. March 2015.
- CRF tables from Belgium (version June 2016). Available via: http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/9492.php
- Entranze, data on energy consumption. Available via: http://www.entranze.enerdata.eu/#/share-heating-unit-consumption-per-dwelling-at-normal-climate.html

- SenterNovem, 2007. Kompas energiebewust wonen en werken. Cijfers en tabellen 2007.
- ECN, 2012. Besparingsgetallen energiebesparende maatregelen. ECN report number P15320. ECN-E-12-013.
- EC, 2010. Recommendations on measurement and verification methods in the framework of directive 2006/32/EC on energy end-use efficiency and energy services – Preliminary Draft. 2010.

3.8. EC-B03: FRGE

3.8.1. Description

The objective of this PAM is to improve the energy efficiency of buildings. This results in a reduction of emissions in both ETS and non-ETS sectors.

The Fund for the Reduction of the Global cost of Energy (FRGE) was used to improve the energy efficiency of housings for disadvantaged people via cheap loans (Vito/Econotec, 2015). The FRGE is transferred to the regions on 1 January 2015, and therefore 2014 is the last year included in this PAM.

3.8.2. Methodology

The emission reduction is calculated based on the equipment installed in households and the expected lower energy use of these appliances. The emission reduction is calculated for each year of the lifetime of an investment. Emission reductions are no longer calculated once the lifetime is over and the installation is removed or replaced.

A. BAU scenario

Within the Business-as-usual scenario, no new investments are done for insulation or for installing efficient heat/electricity systems.

B. PAM scenario

Within the PAM scenario, new investments are done for improving energy efficiency. All the investments from 2004 on are part of this scenario. After the expected lifetime of measures, it is assumed that the reduced CO_2 emissions are no longer a result of the tax incentives or subsidies from the federal government.

In the previous assessment (Vito/Econotec. 2015) report, it was indicated that a significant number of people have used a loan from FRGE and also benefited from a tax reduction. To prevent double counting with measure EC-B01, this calculation only includes low-income households that do not pay taxes and who therefore were not able to profit from a tax deduction under the present measure.

The BAU scenario does not take into account that some people will improve energy efficiency in their house even if no tax reductions and subsidies are available (freerider effect), while the PAM scenario does not take a possible multiplier effect into account. It is assumed that the freerider effect and the multiplier effect will compensate each other.

The rebound effect is not included in the emission reduction calculation, but it probably influences the achieved emission reduction.

The emission reduction is calculated with the following formula:

$$\boldsymbol{ER_{FED} = AF \times \sum_{i} (N_i \times UER)}$$

With:

ER_{FED}	Federal emission reduction (kton CO_2-eq)
AF_i	Allocation factor per type of investment (%)
N_i	Number of applications per type of investment
UER_i	Unit emission reduction per type of investment (kg CO_2)

3.8.3. Main assumptions

A. BAU scenario assumptions

For the Business-as-usual scenario, it is assumed that no new investments are done for insulation or for installing efficient heat/electricity systems.

B. PAM scenario assumptions

Number of applications

For 2014 Vito/Econotec (2015) used a distribution based on the information for non-taxpayers of 2008-2013. For this year, two scenarios with respect to the number of applications in 2014 were used:

- a minimum and likely scenario where the total number of applications in 2014 is the same as in 2013.
- a maximum scenario where there is a (moderate) increase in applications, similar to the increase between 2012 and 2013.

This approach has also been followed in the present assessment:

3.8.4. Data sources

Data sources for each indicator are presented in Table 30.

Indicators	Ex-ante values	Ex-post values
AF	Equal to EC-B01 (Vito/Econotec. 2015)	Equal to EC-B01 (Vito/Econotec. 2015)
Number of applications (N)	2008-2013: FRGE 2014: Vito/Econotec. 2015 (see assumptions)	n.a. (no new applications)
Emission factor (EF)	Equal to EC-B01 (Vito/Econotec. 2015)	Equal to EC-B01 (Vito/Econotec. 2015)

Table 30: Description of data sources

3.8.5. Results

From 2015 onwards, the regions are responsible for this tax reduction and the allocation factor for the federal government for new tax reductions and subsidies will be 0%. The CO_2 emission reduction gained from measures before 2015 are still allocated to the federal government.

After the expected lifetime of measures, it is assumed that the reduced CO_2 emissions are no longer a result of the tax incentives or subsidies from the federal government. Therefore, the annual emission reductions decrease from 2022 on. Figure 8 presents the minimum and maximum scenario for the annual CO_2 emission reductions.

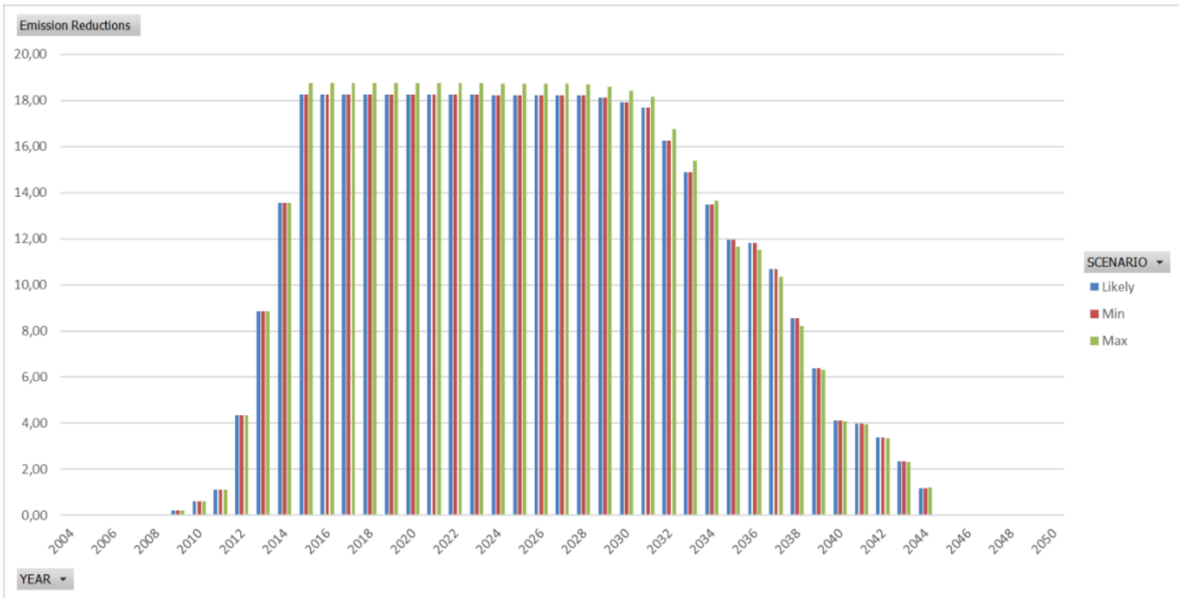


Figure 8: Annual emission reductions (minimum, maximum and likely scenarios)

3.8.6. Discussion

This emission calculation contains many variables and uncertainties. The main uncertainties in the emission reduction calculation include the emission reduction units and the average lifetime. The energy reduction units have been compared to energy reduction units in several other studies, which show similar values and therefore the average emission reduction is probably the most likely.

3.8.7. References

- Vito/Econotec, 2015. Evaluation of the impact of policy instruments and measures implemented in the context of the Federal climate policy. March 2015.

3.9. EP-A01: Offshore wind energy and tidal energy

3.9.1. Description

The objective of this PAM is to stimulate the production of green electricity in the North Sea area under Belgian jurisdiction, which falls under the responsibility of the federal government. This results in a reduction of emissions in the ETS sector, and not in non-ETS.

Green electricity production based on offshore wind is stimulated with a system of green (federal) certificates. Green certificates are used to certify that a given amount of green electricity is produced by an electricity producer and can be sold at a guaranteed fixed minimum price. In 2013, this minimum price guarantee was adjusted to a system with a flexible price for new offshore wind energy locations.

On 18 December 2019, the federal government set a target of 4011 MW for electricity from offshore wind in 2030 (Source: European Commission, 2019).

3.9.2. Methodology

The emission reduction is calculated based on the electricity production and the assumption that this will result in a reduction of natural gas use for electricity production.

A. BAU scenario

Within the Business-as-usual scenario, no offshore wind parks are constructed. The electricity production from offshore wind is zero.

B. PAM scenario

Within the PAM scenario, we have calculated a minimum and a maximum annual emission reduction; in both scenarios there is no increase of capacity post 2030. The minimum emission reduction is calculated with the assumption of 3100 full load hours, the maximum emission reduction is calculated with the assumption of 3500 full load hours. It is also assumed that offshore wind turbines are replaced at the end of their lifetime. This is in line with the NECP scenario (European Commission, 2019). The likely scenario is equal to the minimum scenario.

The emission reduction is calculated with the following formula:

$$\boldsymbol{ER_{FED} = AF \times P \times EF}$$

With:

ER_{FED}	Federal emission reduction (kton CO_2-eq)
AF	Allocation factor (%)
P	Electricity production (MWh)
EF	Emission factor (kton CO_2-eq/MWh)

The electricity production in future years is estimated by multiplying the installed capacity with average full load hours. The emission reduction in future years is calculated with the following formula:

$$\boldsymbol{ER_{FED} = AF \times C \times H \times EF}$$

With:

ER_{FED}	Federal emission reduction (kton CO_2-eq)
AF	Allocation factor (%)
C	Installed capacity (MW)
H	Full load hours (h)
EF	Emission factor (kton CO_2-eq/MWh)

3.9.3. Main assumptions

A. BAU scenario assumptions

It is assumed that no offshore wind farms are constructed and the electricity production from wind farms is zero.

B. PAM scenario assumptions

Electricity production (P)

The electricity production for future years is calculated by multiplying the expected installed capacity and the full load hours.

Installed capacity (C)

The installed capacity for future years (2021-2030) is based on information from the National Energy and Climate Plan, which indicated an increase of installed capacity of 1750 MW by 2030. The plan lays out an indicative timeline, in which it is foreseen to have an additional 700 MW installed by 2025 and another 1050 by 2027 (see Table 31). The target for 2030 amounts to 4011 MW.

Year	Installed capacity (MW)
2020	2 261
2025	2 961
2027	4 011
2030	4 011

Table 31: Expected installed capacity for the years 2021-2030

Concerning wave energy, it has to be mentioned that as no information on installed capacity could be found in the NECP, this has been set at 0.

Full load hours (H)

An assumption of 3100 full load hours is used for the minimum and likely scenario, while 3500 full load hours is assumed for the maximum scenario.

In 2011, 2014 and 2015, almost no additional offshore wind capacity was installed, and therefore the electricity was produced by wind turbines that were already operational by the beginning of the year. The full load hours can be calculated by dividing the electricity production with the installed capacity. Table 32 illustrates the installed capacity, the electricity production and the calculated full load hours for a selection of years.

Year	Installed capacity (MW)	Electricity production (GWh)	Calculated full load hours
2009	32	82	-
2010	197	190	-
2011	197	709	3 599
2012	381	854	-
2013	708	1 540	-
2014	708	2 216	3 130
2015	712	2 613	3 680
2016	712	2 390	3 357
2017	877	2 870	3 273
2018	1 186	3 411	-
2019	1 559	4 794	-

Table 32: Calculation of full load hours

The full load hours have not been calculated for the years 2009, 2010, 2012 and 2013, because the installed capacity has expanded substantially in these years. In 2015, the installed capacity expanded slightly. The full load hours are calculated by dividing the electricity production in 2015 with the installed capacity in 2015. If we would assume that the newly installed capacity in 2015 did not produce any electricity, then the calculated full load hours would be 2 613 / 708 * 1 000 = 3 691 hours.

Similar to the Vito/Econotec report, we assumed the full load hours to be somewhat lower than the calculated full load hours for these three years, because the wind turbines are relatively new. Older wind turbines probably have less full load hours due to maintenance or technical malfunctioning.

Emission factor

Electricity: it is assumed that the electricity would not have been produced in a CCGT power plant (see section 3.1). It is also possible that the reduction of electricity production takes place in coal fired power plants (with a higher emission factor) or in nuclear power plants (with a lower emission factor).

When electricity transport and distribution losses (4.5%) are also taken into account, then the emission factor of electricity consumption is 381 g CO_2/kWh in 2021 as the loss factor is applied to the electricity EF. This last factor, which evolves over time, has been adopted for this study.

3.9.4. Data sources

Data sources for each indicator are presented in Table 33:

Indicators	Ex-ante values	Ex-post values
AF	100% for federal	
Electricity production (P)	2008-2009: Vito/Econotec (2015) 2010-2015: IEA, 2016 2016-2019: Eurostat, 2019	n.a.
Capacity (C)	n.a.	NECP. See assumptions
Full load hours (H)	n.a.	See assumptions
Emission factor (EF)	Vito. Econotec (2015), see assumptions	

Table 33: Description of data sources

3.9.5. Results

In the NECP, it is expected that the installed capacity will increase up to 2 261 MW in 2020. This is more than the goal of 2000 MW by 2020. For 2030, the target of 4 011 MW has been set.

The annual CO_2 emission reduction due to offshore wind energy will increase until 2030. After 2030, the CO_2 emission reductions might increase even further if end of life turbines are replaced by new and bigger installations, and if hybrid interconnections are made. This is not taken into account here. Figure 9 presents minimum and maximum scenario for the annual CO_2 emission reductions.

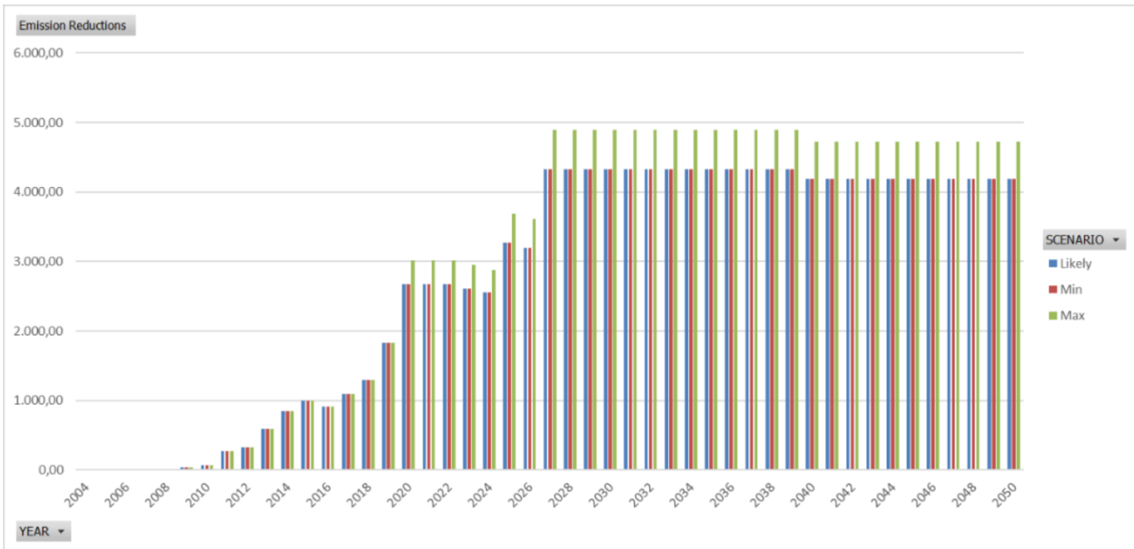


Figure 9: Annual emission reductions (minimum, maximum and likely scenarios)

3.9.6. Discussion

The main uncertainties in the emission reduction calculation include the amount of full load hours and the future installed capacity. The likely scenario is equal to the minimum scenario and could be an underestimation of the actual emission reductions.

3.9.7. References

- Vito/Econotec, 2015. Evaluation of the impact of policy instruments and measures implemented inthe context of the Federal climate policy. March 2015.
- IEA, 2016. IEA Wind TCP. 2015 annual report. August 2016. Available via:https://www.ieawind.org/annual_reports_PDF/2015/Belgium.pdf
- Eurostat, 2020. SHARES Belgium. Available via: https://ec.europa.eu/eurostat/web/energy/data/shares
- European Commission, 2019. National Energy and Climate Plan for Belgium 2021-2030. Available via: https://ec.europa.eu/info/energy-climate-change-environment/implementation-eu-countries/energy-and-climate-governance-and-reporting/national-energy-and-climate-plans_en

3.10. EP-A02: Energy taxation

3.10.1. Description

The objective of this PAM is to increase the production of green electricity. This results in a reduction of emission in ETS sector and not in non-ETS sectors.

Production of green electricity is stimulated at both the federal level and the levels of the three regions. The regions offer ecology grants that can be cumulated with the federal measures. The federal government has also taken several additional measures which reduce the relative cost of electricity from renewable sources. The federal government has established a special excise tax on fossil fuel for electricity production (for heavy oil and for coal). Also, the regions offer ecology grants that can be cumulated with the federal measures (Vito/Econotec, 2015).

Due to these taxes, the use of biomass and natural gas are relatively cheaper. Within this PAM, only the impact of these taxes on the use of biomass is quantified.

3.10.2. Methodology

The emission reduction is calculated based on the electricity production and the assumption that this will result in a reduction of coal combustion for electricity production.

A. BAU scenario

Within the Business-as-usual scenario, the coal fired power plants continue to produce electricity, without co-combustion of biomass. The use of biomass for electricity production is zero.

B. PAM scenario

Within the PAM scenario, biomass is used for electricity production (in plants for electricity production only). This does not include the combustion of the renewable fraction of waste. Annual emission reductions are calculated within one scenario, assuming that capacity for biomass combustion will not increase compared to 2014.

The emission reduction is calculated with the following formula:

$$\boldsymbol{ER_{FED} = AF \times P_{Bio} \times EF}$$

With:

ER_{FED}	Federal emission reduction (kton CO_2-eq)
AF	Allocation factor (%)
P_{Bio}	Electricity production from biomass (GWh)
EF	Emission factor (ton CO_2-eq/MWh)

3.10.3. Main assumptions

A. BAU scenario assumptions

Within the Business-as-usual scenario, it is assumed that the coal fired power plants continue to produce electricity, without co-combustion of biomass. The use of biomass for electricity production is zero.

B. PAM scenario assumptions

Allocation factor

The allocation factor has been calculated in the Vito/Econotec report (2015), based on the relative size of the impact of these measures on the cost of electricity production. Other measures with an impact on the cost of electricity production are the carbon price and the green certificates for biomass. The tax on coal has a relative impact of 5.71% of the cost of electricity production. This is used as an allocation factor for the federal part.

Electricity production from biomass

In Vito/Econotec (2015) and ICEDD (2017), two scenarios were considered: a minimum (and likely) scenario, with no increase of biomass electricity production for 2015-2020 compared to 2014; and a maximum scenario, with a linear increase of co-combustion of biomass based on an extrapolation of the electricity production in the period 2008-2014.

In this update, only one scenario will be considered, i.e. the minimum scenario, as from the NECP (European Commission, 2019) it has become clear that electricity generation from biomass will be decreasing in the future. Hence, the previous assumption that co-combustion will increase in a linear fashion can no longer be considered valid.

Emission factor

This measure will result in a decrease of coal combustion and an increase of natural gas and biomass combustion. It is assumed that the increased use of biomass will result in a reduced use of coal. Therefore, an emission factor of 950 gram CO_2/kWh has been used (Vito/Econotec, 2015).

In 2016, the last coal fired power plant closed. Since the electricity production from biomass is lower than the electricity production from coal fired power plants in the last years, this emission factor is still valid.

3.10.4. Data sources

Data sources for each indicator are presented in Table 34:

Indicators	Ex-ante values	Ex-post values
AF	See assumptions	See assumptions
Electricity production from biomass (Pbio)	Eurostat table nrg_105a. http://ec.europa.eu/eurostat/web/products-datasets/-/nrg_105a Eurostat table nrg_ind_pehcf	See assumptions
Emission factor (EF)	Vito. econotec (2015), see assumptions	Vito. econotec (2015), see assumptions

Table 34: Description of data sources

3.10.5. Results

Electricity production from biomass co-combustion increased in the period 2000-2012, but it decreased in 2013 and 2014. Coal prices were relatively low in Europe in these years, which could have influenced the smaller amount of biomass that has been combusted. Figure 10 shows the likely scenario for CO_2 emission reduction due to biomass combustion.

In 2016, the last coal fired power plant in Belgium closed. Co-combustion of biomass in a coal fired plant is therefore not possible in the future, but Belgium also has power plants solely powered by biomass. However, the NECP indicates some of these installations will be closed or redirected over time.

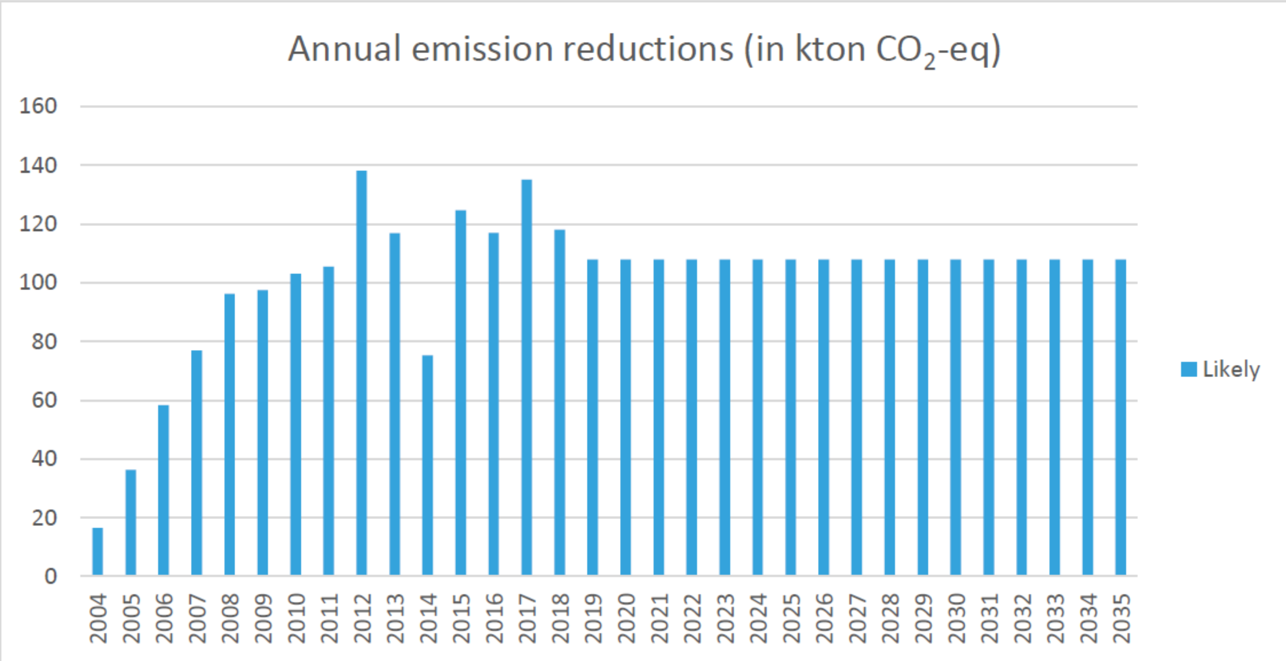


Figure 10: Annual emission reductions (minimum, maximum and likely scenarios)

3.10.6. Discussion

The electricity production from biomass in this study only includes the biomass combustion in electricity plants (only main activity electricity plants). It does not include the renewable fraction of waste and it does not include the electricity production in other installations. Therefore, the amount of electricity production from biomass in this PAM is lower than the electricity production from biomass in the Belgian energy statistics of renewable energy (as presented in the SHARES data for Belgium: https://ec.europa.eu/eurostat/web/energy/data/shares).

The main uncertainties in the emission reduction calculation include the future use of biomass in electricity production. The likely scenario is equal to the 'old' minimum scenario and could be an underestimation of the actual emission reductions.

3.10.7. References

- Vito/Econotec, 2015. Evaluation of the impact of policy instruments and measures implemented in the context of the Federal climate policy. March 2015.
- Eurostat table nrg_105a: Supply. transformation and consumption of electricity - annual data. Available via: http://ec.europa.eu/eurostat/web/products-datasets/-/nrg_105a
- Eurostat table nrg_ind_pehcf: Gross production of electricity and derived heat from combustible fuels by type of plant and operator – annual data. Available via: https://ec.europa.eu/eurostat/databrowser/view/NRG_IND_PEHCFcustom_578514/default/table?lang=en
- European Commission, 2019. National Energy and Climate Plan for Belgium 2021-2030. Available via: https://ec.europa.eu/info/energy-climate-change-environment/implementation-eu-countries/energy-and-climate-governance-and-reporting/national-energy-and-climate-plans_en

3.11. IP-A06: Tax deduction for energy savings

3.11.1. Description

For decades, companies have been enjoying a tax advantage when they invest in energy savings, at a percentage tax deduction level that has varied in time. Information from FPS Finance revealed that the annual amount of investments benefiting from this tax deduction ranged between 40 to 180 million €. For 2004, the tax deduction was 13.5% for energy saving investments by companies (instead of 3.5% for standard investments). For the year 2009 the deduction level was raised to 15.5% for energy saving investments, while standard investments no longer benefited from a tax deduction, before being lowered again to 13.5% for the years 2010 and 2011. From 2011 the deduction level for energy saving investments has undergone several changes. It reached a rate of 15.5% in 2012, 14.5% in 2013 and 13.5% for the following period 2014-2019, before being raised to 20.0% in 2020 and 25.0% from the years following.

This PAM results in a reduction of emissions in both ETS and non-ETS sectors.

3.11.2. Methodology

The impact of the measure is not easy to evaluate, because there is no information available about the types of investments made, nor about the sectors. Consequently, the evaluation is based on amounts invested.

The evaluation is based on an estimate of the average payback time, using the formula:

$$\boldsymbol{ER_{FED} = AF \times ER_{TOT}}$$

$$\boldsymbol{ER_{FED} = AF \times \left(\frac{I}{PB_{time} \times E_{price}}\right) \times EF}$$

With

$\mathbf{ER}_{FED}$	Emission reduction within the framework of the federal climate policy
$\mathbf{ER}_{TOT}$	Emission reduction projected for the PAM
$\mathbf{PB}_{time}$	Payback time
$\boldsymbol{AF}$	Allocation factor
$\mathbf{EF}$	Emission factor
$\mathbf{E}_{prices}$	Energy prices

3.11.3. Main assumptions

A. General assumptions

- Even though the tax deduction is an existing measure from 1992, the effect of the measure has been considered for investments starting from 2004.
- It should be noted that the deduction rate considered from 2004 for the calculation of the energy saving is the whole rate, and not only the increase in deduction rate since 2004 (i.e. the measure has been fully estimated).
- PAM effect has been assumed to be allocated in equal proportion within the ETS and non-ETS policy frameworks.

- Annual amount of energy savings is assumed constant for the period projected as long as annual investments (since 2019) are kept steady.
- The expected time life of the investments is assumed to be 10 years.
- Energy savings due to these investments are assumed to be adopted for all the main energy carriers in the industrial sector (electricity, natural gas, gas/heavy oil) in a weighted way, thus keeping the energy shares estimated for the industrial sector in the BAU scenario.
- Since the deduction rate is small, the free rider effect can be expected to be high. Therefore, it is important to exclude the savings corresponding to the free riders. This has been done with the following assumptions:
- All investments with a payback time up to two years, and only those, are carried out spontaneously; all energy saving investment possibilities are evenly distributed over the payback time.
- The impact of the measure is to increase the payback-time ceiling, which rises from two years to 2/(1-td) years, where it is the company profit tax rate and d the net tax deduction rate.
- The net tax deduction rate is the difference between the deduction rate for energy saving investments (13.5% until 2008, 15.5% for 2009, 13.5% for 2010 and 2011, 15.5% in 2012, 14.5% in 2013, 13.5% from 2014 until 2019, 20% in 2020, and 25% from 2021) and that for other investments (3% until 2007, 0% from 2008).
- Default emission factors (EF) from 2006 IPCC Guidelines have been applied for the estimation of this PAM. Belgium uses ETS emissions data in its national GHG emission inventory and therefore country specific EFs could not be derived with the information provided in the CRF tables. For this reason, default 2006 IPCC Guidelines emission factors are recommended as they are consistent with approaches followed at plant level under the ETS framework. For the EF for electricity (grid EF), this PAM uses the grid EF which has been used consistently in all PAMs estimated in this study.

3.11.4. Data sources

The data sources used for the estimation of the PAM are presented in the following table:

Indicators	Source
Annual Investment	Personal communication with FPS - FPS Finance
Tax deduction	Personal communication with FPS - FPS Finance
Tax deduction rate	Personal communication with FPS - FPS Finance
Emission factors	2006 IPCC Guidelines
Energy prices	Eurostat
Energy consumption split by energy carrier	Statistics Belgium

Table 35: Description of data sources

3.11.5. Results

The emission reductions achieved by the implementation of the PAM increase from 3 kt CO_2-eq in 2004 to 1 360 kt CO_2-eq in 2032. From 2032 onwards the reductions achieved slightly decrease until 2040, where it reaches 1 295kt CO_2-eq from 2040 until 2050. The following figure illustrate the emission reductions achieved from 2004 to 2050 by the PAM:

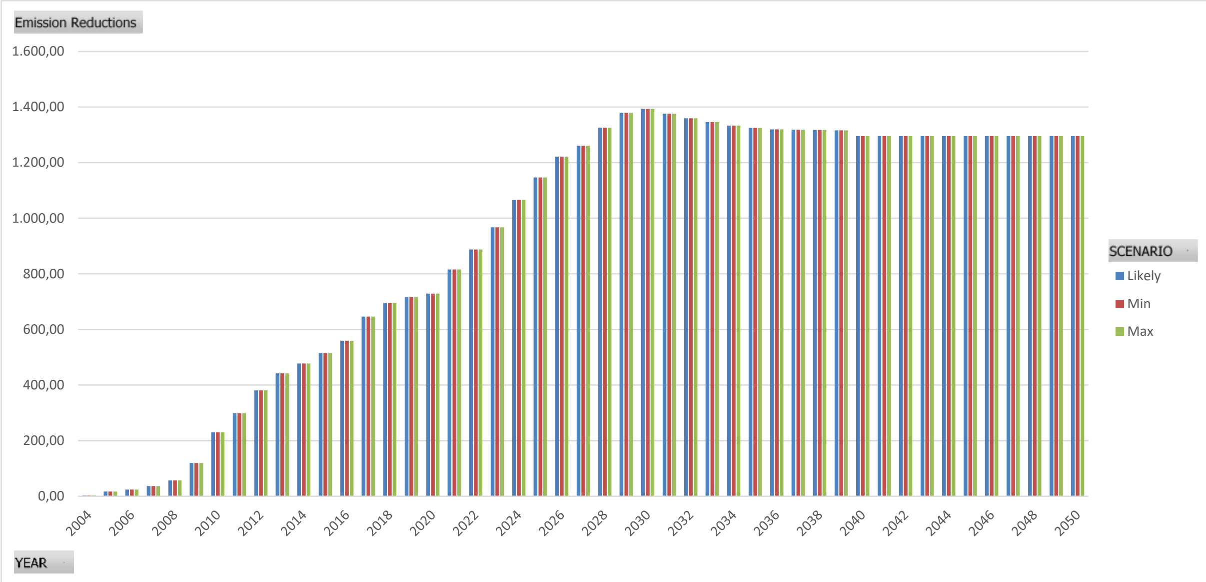


Figure 11: Annual emission reductions (minimum, maximum and likely scenarios)

3.11.6. Discussion

The current methodology estimates energy savings from the total amount invested and energy prices. This methodology should be updated on a calculation of energy savings based on the amount invested by sector. Information on the use of the investment would enable a calculation of a BaU and a PAM scenarios of energy consumption, which in principle, should be considered a more robust methodology for assessing the overall effect and a more precise procedure for distinguishing the emission reduction allocated within the ETS and non-ETS policy framework.

3.11.7. Update of the PAM

The initial consultations conducted in January and February 2021 with FPS Finance for the 2021 update of the PAM provided revised data on the tax reduction rates for both energy saving investments and other investments for the period 2009-2021. This data was received from Jean-Baptiste Traversa from the Tax Policy Unit of FPS Finance and was incorporated into the PAM. In addition, these initial consultations provided revised data concerning the tax rate on company profits (CIT rate) for the period 2004-2019, which was subsequently incorporated into the PAM. However, this initial data still lacked specifics on the total annual investments and total tax deductions for the period 2004-2019, for which additional consultations were required with Jean-Baptiste Traversa.

The second round of consultations in March 2021 with Jean-Baptiste Traversa allowed for the incorporation of the missing revised data on the total annual investments and total tax deductions for the period 2004-2019, which was subsequently incorporated into the PAM.

Throughout the consultation process, no information was available on the use of the investments, so it has not been able to update the methodology regarding this for the 2021 edition of the PAMs. Therefore, it is still assumed that the energy savings due to these investments are to be adopted for all the main energy carriers in the industrial sector (electricity, natural gas, gas/heavy oil) in a weighted way.

The estimations of the PAM require the emission factors for the main energy carriers in the industrial sector (electricity, natural gas, gas/heavy oil) in a weighted way. In the second round of updates of the PAM in March 2021, these emission factors have been updated from the emission factors based on the 1996 IPCC Guidelines to the emission factors based on the 2006 IPCC Guidelines.

3.11.8. References

- IPCC, 2006. Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.

- Eurostat, 2017. Electricity prices for domestic consumers - bi-annual data (from 2007 onwards).
- Statistics Belgium, 2017. Energy consumption statistics - Electricity – GWh.

3.12. OB-A03: EMAS certification

3.12.1. Description

The federal government has fixed as objective that by 2007 all public services should be EMAS certified. EMAS certified entities set themselves objectives on the reduction of their energy consumption and an increasing use of bicycle and public transport for their employees. Besides, the management contracts of the NMBS/SNCB group of companies foresee the establishment and implementation of an environmental policy plan.

This PAM results in a reduction of emissions in both ETS and non-ETS sectors.

3.12.2. Methodology

In the absence of additional information on the individual impact of this measure, the current estimation is based on an estimation of the total emission reduction achieved by EMAS per employee:

$$\mathbf{Emission\ Reduction}_{\boldsymbol{t}} = \mathit{Unitary\ Emission\ Reductions}_t \cdot \mathit{Employees}_t$$

$$\boldsymbol{Unitary\ Emission\ Reductions_t} = \mathit{BAU\ Energy\ Consumption}_{\ t} \cdot \mathit{Impact\ EMAS} \cdot EF_t$$

With

Impact EMAS	emission reductions due to the implementation of EMAS
EF	emission factor

Despite the methodology relies on the calculation of a BaU energy consumption, the estimation of an entire BaU and with measures scenarios was not carried out.

According to the Federal Institute for Sustainable Development (IFDD), the following six out of the total fourteen federal public services are EMAS certified in 2020:

- FPS Health, food chain safety and environment – EMAS certified in 2007
- FPS Mobility and Transport – EMAS certified in 2008
- FPS Employment, Labour and Social Dialogue – EMAS certified in 2009
- FPS Justice – EMAS certified in 2015
- FPS Economy, SMEs. Self-Employed and Energy – EMAS certified in 2007
- Federal Public Planning Services (FPPS) Science Policy – EMAS certified in 2006

The missing data obtained from the environmental statements from each of the federal public services was completed using linear interpolation, padding, and applying average percentage difference between FTE and number of employees. The data of employees from 2021 has been estimated using the number of buildings as a proxy.

3.12.3. Main assumptions

A. General assumptions

- The expected number of institutional buildings certified is kept constant throughout the period projected for the most likely (and minimum) scenario. The aim of EMAS certification for all the buildings with more than 100 FTE would be achieved in the maximum scenario by following the mean penetration noted in the historical period.
- The Unitary Emission reduction and the impact of EMAS are kept constant throughout the period projected at 4% for electricity and a 15% for NG/HO. The values have been checked and are in the same order of magnitude of some federal public services such as FPS Health, FPS Mobility, and FPS Employment, while not for others such as FPS Justice, FPS Economy and the Federal Public Planning Services (FFPS) Science Policy. Therefore, these figures are required to be validated in the future for each of the federal public services.
- It is not expected a change over time in the share of each fuel type for heating in the EMAS buildings regarding the percentages reported for 2012.
- For the maximum scenario (optimistic) the target for 2020 is assumed to be fully achieved, whilst the effective reductions projected in the minimum and likely scenarios are adjusted according to the historical time series.
- Missing employee numbers between years has been calculated using linear interpolation as there were gaps in the available environmental statements.
- Missing employee and building numbers have been estimated using padding back to the first EMAS certified year of the respective FPS and up to 2021 as there were gaps in the available environmental statements.
- Missing employee numbers for federal public services without any employee numbers have been estimated from the available FTE data using the average percentage difference between FTE raw data and employee raw data over all the EMAS certified federal public services. This was required as multiple environmental statements solely presenting FTE data, without information on the total number of employees the methodology of this PAM relies on.

3.12.4. Data sources

The data sources used for the estimation of the PAM are presented in the following table:

Indicators	Source
Employees under EMAS	Environmental statements of each EMAS certified FPS
Buildings certified	Environmental statements of each EMAS certified FPS
BaU Energy consumption per employee	VITO/ECONOTEC 2015
Impact of EMAS	2014 EMAS report
EF	IPCC 2006

Table 36: Description of data sources

3.12.5. Results

The following figure illustrate the emission reductions achieved from 2004 to 2050 by the PAM.

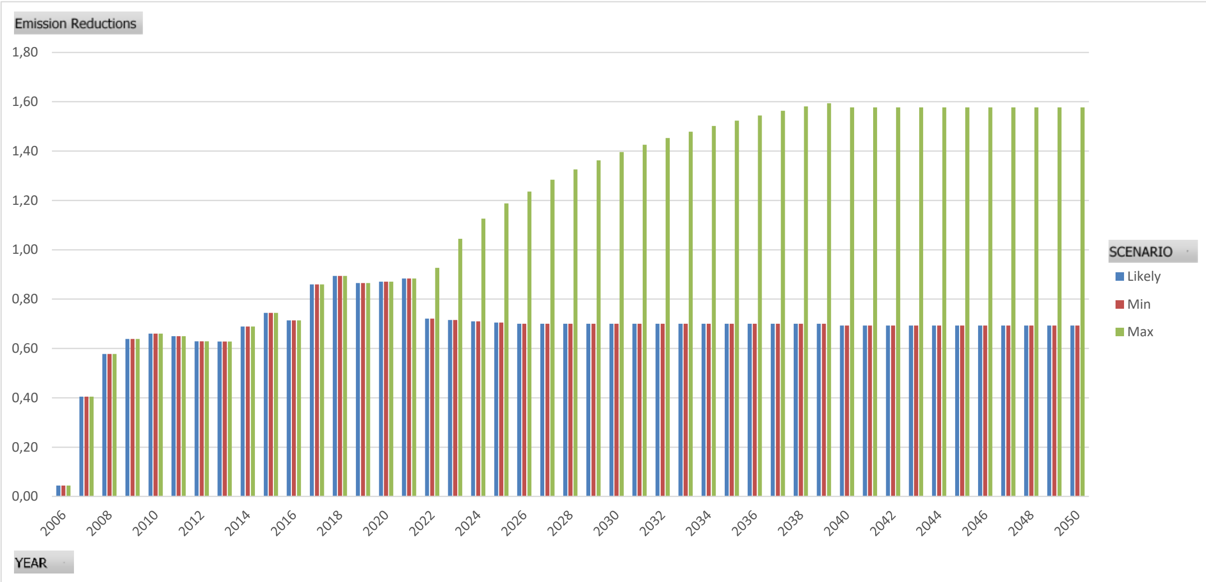


Figure 12: Annual emission reductions (minimum, maximum and likely scenarios)

3.12.6. Discussion

The assessment of this PAM is based on an impact factor for the implementation of EMAS in public buildings from a 2014 report. The information collected for the update of the PAM in 2021 partially confirmed the impact factor used. However, future updates of this PAM should consider the update of this impact factor in line with information collected on energy consumptions in building from the different entities involved.

More updated information on number of employees working under organizations EMAS certified and/or updated energy consumption of the buildings would enable a better approximation to the PAM.

3.12.7. Update of the PAM

The initial consultations conducted in January and February 2021 for the 2021 update of the PAM presented additional general information concerning the EMAS PAM. This data was received from Marielle Smeets, Corporate Strategy & Culture at FPS Health, but was predominantly qualitative and the quantitative data was not consistent with the requirements of the PAM to update the current figures. She did suggest consulting the Federal Institute for Sustainable Development (IFDD), which maintains a database with all the activities of the federal public services in environmental management, including EMAS certifications.

Further consultations were conducted in March 2021 with Marie-Line Gabriel from the Federal Institute for Sustainable Development (IFDD). However, this consultation revealed that the IFDD database does not contain information concerning the number of EMAS employees and buildings of EMAS certified federal public services. Marie-Line Gabriel did provide the following list with the six out of the total fourteen federal public services that are EMAS certified in 2020:

- FPS Health, food chain safety and environment
- FPS Mobility and Transport
- FPS Employment, Labour and Social Dialogue
- FPS Justice
- FPS Economy, SMEs, Self-Employed and Energy
- Federal Public Planning Services (FPPS) Science Policy

The consultation process was continued by approaching each of these six federal public services for the required data to update the PAM. However, only information on the number of employees and buildings was provided by Michiel Maertens from FPS Economy. Therefore, data on the number of employees and buildings of the remaining five EMAS certified federal public services required to update the PAM was extracted from the yearly environmental statements.

3.12.8. References

- 2014 EMAS report
- Environmental Statements from: https://www.health.belgium.be/nl/emas
- Environmental statements from: https://werk.belgie.be/nl/over-de-fod/emas
- Environmental statements from: https://justitie.belgium.be/nl/overheidsdienst_justitie/engagement/milieumanagement
- Environmental statements from: https://www.belspo.be/belspo/organisation/env_nl.stm
- IPCC 2006 Guidelines

3.13. OB-B01: Photovoltaic panels on roofs of Federal government buildings

3.13.1. Description

In March 2007, the Federal government decided an objective of 1 km² of photovoltaic panels on roofs of the public buildings. This is to be achieved by three measures:

1. Roofs will be made available for installing PV panels;
2. Installation of PV panels by government. via FEDESCO/Buildinsagency;
3. the three companies of NMBS/SNCB group and Infrabel have committed themselves to consider building and installing renewable energy equipment (e.g. solar or wind) via partnerships;
4. The defence sector has also started to install PV panels (barracks of Saffraanberg (Sint Truiden) and plans to realize supplementary projects in Flanders until 2030 and in Wallonia if the local legislation changes to permit these installations.

This PAM results in a reduction of emissions in ETS sector.

3.13.2. Methodology

A. BAU scenario

The BAU scenario is considered as one without any future photovoltaic panels being installed on roofs of the public buildings and no wind or solar power being installed by NMBS/SNCB or Infrabel.

B. PAM scenario

In the PAM scenario we consider the installation of PV by government via FEDESCO/Buildinsagency and by NMBS/SNCB according to the plans that have been communicated to us. We also include the installation of wind power by NMBS/SNCB.

The annual emission reduction of this PAM is estimated as the sum of reductions from PV and wind which are calculated as follows:

$$\boldsymbol{Emission\ Reduction\ PV} = (\boldsymbol{P_{solar}} \cdot \boldsymbol{E_{solar}} \cdot \boldsymbol{A_{solar}}) \cdot \boldsymbol{EF}$$

$$\boldsymbol{Emission\ Reduction\ wind} = (\boldsymbol{P_{wind}} \cdot \boldsymbol{P_{wind}} \cdot \boldsymbol{A_{wind}}) \cdot \boldsymbol{EF}$$

Where:

$\boldsymbol{P_{solar}}$	Average yearly installed capacity of PV panels (kWp)
$\boldsymbol{E_{solar}}$	Efficiency PV (kWh/kWp)
$\boldsymbol{A_{solar}}$	Allocation factor (to the federal measure) for PV panels (%)
$\boldsymbol{P_{wind}}$	Average yearly installed capacity of wind turbines (MW)

E_{wind} Average annual equivalent number of full load hours (h)
A_{wind} Allocation factor (to the federal measure) for wind turbines (%)
EF Emissions factor (ton CO_2eq/MWh)

3.13.3. Main assumptions

A. PAM scenario assumptions

- Average yearly installed capacity of PV panels (kWp):
    - Fedesco/Buildingsagency: for the period 2010-2020 we have the data on actual installed capacity (see below “data sources”).
    - For the period 2021 to 2026 funding has been requested to install further capacities, but at the time of redaction of this report, these funding have not yet been approved.
    - NMBS/SNCB: For the period 2010-2020 we have the data on actual installed capacity (see below “data sources”). For the period 2020-2022, we have data about planned projects. From 2022 onwards as we do not have any information on future/objective of the measure we keep the 2022 value constant.
    - Infrabel: Data concerning the installation of PV on buildings has been submitted for the period 2010 to 2020 and planned projects for 2021 and 2022. Furthermore, Infrabel submitted data concerning PV and wind installations on which they hold shares.
- Efficiency PV (kWh/kWp) varies a lot between individual projects. It has been set to 912 kWh/kWp (instead of 900 kWh/kWp in the previous evaluation). This value corresponds to an average of the production data from existing installations since 2010.
- Average yearly installed capacity of wind turbines (MW): for the period 2008-2020 we use the actual data (see below “data sources). The total final installed capacity of the Greensky wind park connected to the traction network of the Belgian railway is 50 MW. We set a progressive augmentation of installed capacity as to reach 50 MWh in 2025.
- Average annual equivalent number of full load hours (h) is set at 3200 hours as apparent from the data submitted from the Greensky project.
- Allocation factor (to the federal measure) for PV panels (%): the allocation factor from the previous evaluation have been used. They were estimated by comparing the cost of installation with the amount of financial support from regional authorities (only based on green certificates). This was done as in this case it is not possible to directly relate the share of federal financial support in investments made by these institutions (e.g. NMBS/SNCB). The following allocation factors were used :

Year	Allocation Factor
2008-2009	66%
2010	64%
2011	66%
2012	73%
2013-2050	89%

- Allocation factor (to the federal measure) for wind turbines (%): The same method as for PV panels was employed. As in the last assessment, 42% of the reductions have been allocated to the Federal government.

- **Emissions factor** (ton CO_2eq/MWh): this is the emission factor of a CCGT power station (see section 3.1).

3.13.4. Data sources

- Average yearly installed capacity of PV panels (kWp) for Fedesco/Buildingagency has been provided by a personal communication of Buildingagency (January/February 2021). The data is detailed by site of installation and include for some sites also data on production of electricity. The table below sum up the data received.

Address	Elec. Power	Date of availability
Leuze en Hainaut	405.23 kWc	20/06/14
Beveren	301.44 kWc	14/02/16
Dourbes	306 kWc	02/07/15
Bertrix	9.87 kWc	30/11/11
Libramont	27 kWc	05/11/13
Melle (FAVV)	47 kWc	16/09/13
Laeken	110 kWc	19/03/13
Haren	54 kWc	18/07/13
Woluwé	99.6 kWc	23/04/10
Kortrijk	124 kWc	21/12/11
Ciney	40 kWc	21/12/11
Brugge	548.8 kWc	2012
Beveren	196 kWc	2010?
Wilrijk	391.44 kWc	2010
Dourbes	306 kWc	02/07/15
Achêne (Police Fédérale)	19.22 kWc	
Archives de l'Etat (Arlon)	27 kWc	2019
Saint Hubert (Centre de Détention)	55 kWc	
Gent (Justitie)	484 kWp	2014
Gent (Rijksarchief)	14 kWp	2014
Dendermonde (Justitie)	249 kWp	2012
Hasselt (Federale Politie)	27 kWp	
Bornem (Finshop)	621 kWp	
Bruxelles (IRSNB)	62.4 kWp	31/10/14
Bruxelles (Space Pôle Uccle)	56 kWc	nov/20
Vottem (112 centrum)	48 kWc	12/07/05
Gent (Gerechtgebouw)	219 kWp	En projet
Bruxelles (Portalis)	150 kWp	En projet
Liège Tour des Finances	126 kWc	
Antwerpen (Forensisch Psychiatrisch Centrum)	511.3kWp	2018
Dendermonde	280 kWp	in uitvoering

Haren	48.96 kWp	in uitvoering
Bruxelles (ORB)	40.30 kWc	30/09/20
Bruxelles (IRM)	22.36 kWc	22/09/17
Bruxelles (IRM)	15.5 kWc	30/09/20
Hasselt Veiligheidssite (met RCA)	65 kWp	
Saint Hubert	55 kWc	en cours
Bruxelles (Ecole Européenne Uccle)	108 kWc	

Table 37: Average yearly installed capacity of PV panels

- Average yearly installed capacity of PV panels (kWp) for NMBS/SNCB: Data transmitted from NMBS/SNCB.

	2016	2017	2018	2019	2020
Installed capacity (kWp)	91	619	2 469	6 426	6 426
Production (MWh)	70	525	1 851	4 115	6 362

Table 38: Average yearly installed capacity of PV panels (kWp) for NMBS/SNCB

- Average yearly installed capacity of PV panels (kWp) for Infrabel: Data transmitted from Infrabel.

Year	Total	
	Capacity	Production
	kWp	kWh
2010	11	9 971
2011	27	16 130
2012	46	37 643
2013	46	41 393
2014	72	60 036
2015	72	69 098
2016	72	65 808
2017	342	233 126
2018	403	438 884
2019	403	472 966
2020	510	511 000
2021	1 520	
2022	2 185	

Table 39: Average yearly installed capacity of PV panels (kWp) for Infrabel

- The defence sector has submitted data for 500 kWp installed capacity at the barracks of Saffraanberg (Sint-Truiden) since 01/11/2019 and announced a project in Flanders by the horizon of 2030 with 12 700 kWp installed power. Potentially, 8 500 kWp could also be installed in Wallonia, but therefore the legislation must be changed. This las project has been considered for the max scenario.

- According to personal communication, there has been no new installation of wind turbines since the 2016 PAMs report.

3.13.5. Results

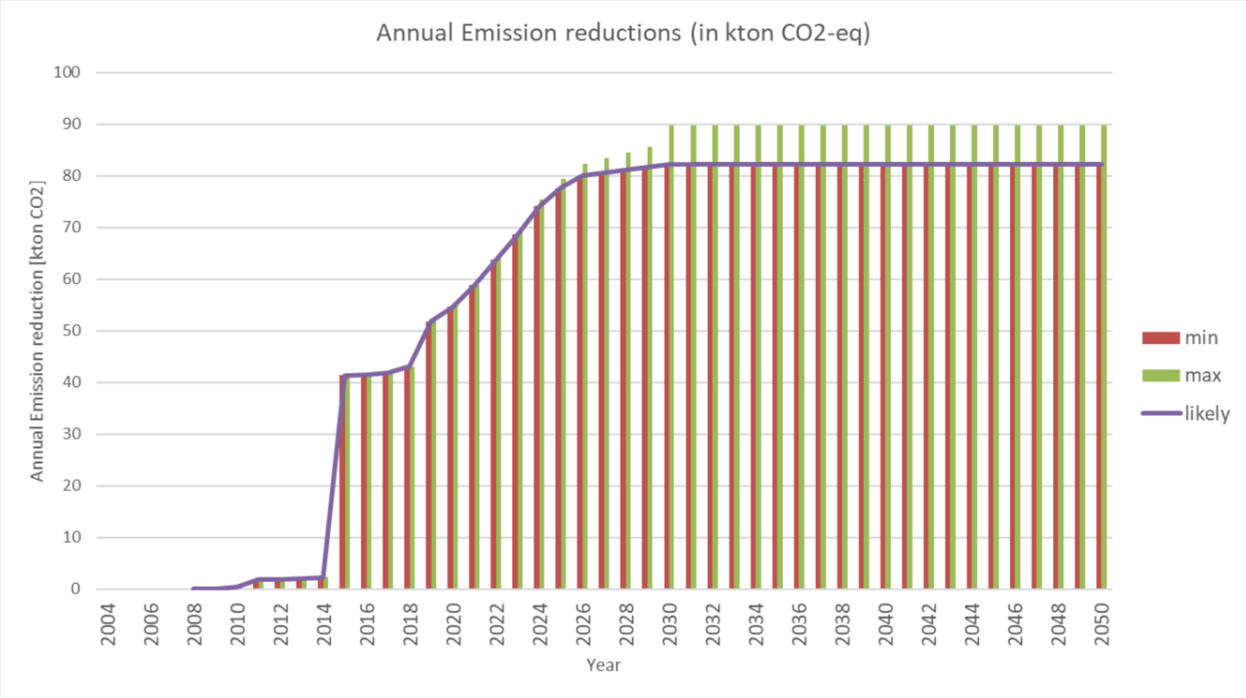


Figure 13: Annual emission reduction of the PAM OB-B01

Most of the reduction are related to the wind turbines connected to the traction network of Infrabel. Thus, the annual emissions reductions profile follows the date of installation of wind turbines. The minimum and most likely scenario mean that no additional capacities will be installed after 2020. The maximum scenario means that all planned investments will be made.

3.13.6. Discussion

Estimations up to 2020 are quite accurate. For the period 2020-2026, two to six M€ are likely to be invested. Estimations are very conservative as no information could be found on commitments/objectives/plans to implement this measure. Eventually one could use the max, min, likely scenarios for setting up different targets for the PV surfaces and wind turbines capacity to be installed.

The emission reductions of PV installation by the defence sector strongly depend on the evolution of the legislation in the Walloon region.

The objective of 50 MW of installed wind capacity connected to the traction network and the calendar of the installation for the additional 50 minus 32 MW capacity is to be validated by FPS mobility and Infrabel/Engie.

Allocation factors are explicitly described in the previous evaluation. They are set to 89 % for Regie and Defence and to 42 % for NMBS/SNCB.

There can be problems of overlapping with regional green certificate scheme. No corrections were foreseen for this problem in this estimation (as well as in the previous estimation).

3.13.7. References

All information used has been transmitted by the Régie des bâtiments, by NMBS/SNCB, Infrabel and by the defence sector.

3.14. OB-B02: Third party financing in public buildings

3.14.1. Description

To improve energy efficiency in public buildings, the Federal government created in 2005 FEDESCO. FEDESCO was financed by the government and invested in projects to increase energy efficiency via e.g. relightings, energy performance contracts, energy monitoring systems and thermal isolation used by the Federal government. At the same time, the buildings agency (Regie der gebouwen/Régie des batiments) have also funded actions to improve the renovation of public buildings, including improvements in energy efficiency. The government agreement of October 2014 stipulated that FEDESCO was to be dissolved and its activities (and personnel) to be incorporated to the buildings agency. The emission reductions due to the investments made by FEDESCO/ buildings agency from 2005 to 2014 and by buildings agency since 2014 are estimated within this PAM. The investments in PV panels are already covered by OB-BO1, so this PAM only covers energy efficiency investments made/to be made by FEDESCO/buildings agency.

In addition to the measures taken by FEDESCO/Building Agency, this PAMs considers also the measures taken to reduce energy consumption by the Defence sector (broader scope than in the previous assessment – Vito/Econotec (2015). The defence sector will reduce energy consumption of buildings by:

- Use of photovoltaic panels (treated in OB-01)
- Energy performance contracts for existing buildings that will be in used for the next decade.
- New infrastructure projects following the NZEB guidelines.

This PAM results in a reduction of emissions in both ETS and non-ETS sectors.

3.14.2. Methodology

A. BAU scenario

The BAU scenario is different for FEDESCO/Building Agency and for the defence sector. For FEDESCO/buildings agency, the investment rate observed during the last five years (3 M€/yr) will be considered as stable until 2050. For the defence sector, the BAU scenario considers no further investments.

B. PAM scenario

With regards to the FEDESCO/Building Agency, the annual emission reduction of this PAM is estimated as follows:

$$\boldsymbol{Emission\ Reduction} = (\boldsymbol{B} \cdot \boldsymbol{UES} \cdot \boldsymbol{AF}) \cdot \boldsymbol{EF}$$

With:

B	Total budget invested in concrete changes to the building (€)
UES	Energy savings per € invested (kWh/€)
AF	Allocation factor (to the federal measure) (%)
EF	Emissions factor (ton CO_2eq/MWh)

With regards to the measures in the Defence sector, the annual emission reduction of this PAM is estimated on the base of the energy consumption reduction as follows:

$$Emission\ Reduction = \left(\sum_i ER_i \cdot EF_i\right) AF$$

Where:

ER: Energy consumption reduction
EF: emissions factor (ton CO_2eq/MWh)
I: electricity, gas, heating oil
AF: Allocation factor (to the federal measure) (%)

3.14.3. Main assumptions

A. General assumptions

For FEDESCO/Building Agency measures:

- **Total budget invested in concrete changes to the building (€)**: we used the data transmitted by the Régie des Bâtiments (see below "data sources") on the budgets of FEDESCO and of the Régie de Bâtiments for renovation of public buildings. The aggregated results are shown in the table below.

Year	Fedesco	Régie	Total	Fedesco (previous assessment)*
2007	187 973.16 €	1 300 000.00 €	1 487 973.16 €	740 520.00 €
2008	251 566.30 €	1 300 000.00 €	1 551 566.30 €	- €
2009	715 090.76 €	1 300 000.00 €	2 015 090.76 €	1 733 689.00 €
2010	3 234 523.81 €	1 300 000.00 €	4 534 523.81 €	1 779 093.00 €
2011	2 485 243.43 €	1 300 000.00 €	3 785 243.43 €	4 072 309.00 €
2012	5 346 162.24 €	1 300 000.00 €	6 646 162.24 €	3 988 336.00 €
2013	1 476 805.33 €	1 300 000.00 €	2 776 805.33 €	4 347 564.00 €
2014	968 396 26 €	1 300 000.00 €	2 268 396.26 €	4 706 792.00 €
2015		3 300 000.00 €	3 300 000.00 €	5 066 020.00 €
2016		3 300 000.00 €	3 300 000.00 €	5 425 247.00 €
2017		2 811 000.00 €	2 811 000.00 €	
2018		2 537 000.00 €	2 537 000.00 €	
2019		2 771 000.00 €	2 771 000.00 €	
2020		3 463 000.00 €	10 050 908.00 €	

Table 40: Total budget invested

*Data for 2012-2016 were estimated data from the previous assessment exercise.

- **With regards to the types of renovation** (which affect the split between fuels which are saved), we used the assumptions communicated by FEDESCO that 20% of savings are electricity and the rest natural gas / oil (60% / 20% respectively).
- **With regards to budget from 2020 onwards the following scenarios are established**:
    - Min and likely scenario: Investments will be made at a rate of 3M€/yr
    - Max scenario: All the PNEC projects will be financed: 30 M€ in three times 2020-2021-2022 for energy savings by relighting and 1 220 581 384 € until 2040 for isolations and HVAC related projects. The 1 220 M€ are assumed to be spent according to the following time frame:
        - 50 908 € in 2020 for energy audits

  - 14 018 688 € annually in 2021 and 2022
  - 66 249 617 € annually from 2023 to 2040.

- Unit energy savings (kWh/€) per € invested: The previous report assumed a constant efficiency factor of 8 kWh/€ invested. Hence not all measures taken can have the same efficiency. Priority measures like insulation of a flat roof will have a much higher efficiency than changing windows. We assume that the efficient measures will be financed first and therefore the saving efficiency will decrease in function of the investments made. Assuming an exponential decay function, where the efficiency decreases in function of the cumulative investments that have been made seems to be the most logical choice. The same function has been used in all three scenarios. The function was calibrated according to the CO_2eq reduction objectives given in the according PNEC project sheets.
- Allocation factor (to the federal measure) (%): the PAM is strictly federal, so the allocation factor was set to 100%.
- Emissions factor (ton CO_2eq/MWh): the emission factor was calculated based on assumptions on type of energy savings achieved according to the fuel (electricity, natural gas, heating oil) (see above the point on Total budget invested in concrete changes to the building (€))

For the defence sector:

- Energy consumption reductions: For the period 2007-2014, we used the data on energy consumption from the previous PAMs report. For the period 2014-2020, we used data transmitted by the defence sector to calculate actual energy consumption reduction per year. For the period 2020-2040, we used the reduction scenario submitted by the defence sector as likely and maximum scenario.

Energy consumption			
Year	Electricity (MWh)	Gas (MWh)	Oil (1000l)
2007	143 796	24 196	116 550
2008	143 426	24 570	125 529
2009	135 775	24 028	123 862
2010	136 104	27 802	141 230
2011	127 920	25 118	117 056
2012	121 132	20 817	130 809
2013	122 373	22 390	128 471
2014	113 588	155 919	19 967
2015	94 887	121 604	19 300
2016	88 079	122 365	15 105
2017	110 215	136 880	16 687
2018	109 573	142 111	18 948
2019	109 573	143 821	18 458
2020	101 841		

Table 41: Energy consumption by buildings of the defence sector

Primary Energy	kWh	teCO2
2014	551 371 690.08	88 980.89
2015	530 136 858.00	91 128.93
2016	500 165 578.00	85 900.15
2017	559 869 758.50	91 956.65
2018	577 163 777.50	96 677.69
2019	604 522 331.50	100 363.31
2030	448 225 875.97	70 657.47
2040	404 784 699.86	59 569.63

Table 42: Estimated consumption of primary energy

Expected end-use energy savings (in ktoe)	Expected annual savings in 2030
Expected savings from individual actions installed/implemented in 2021	0.1134
Expected savings from individual actions installed/implemented in 2022	0.27
Expected savings from individual actions installed/implemented in 2023	0.5376
Expected savings from individual actions installed/implemented in 2024	1.1776
Expected savings from individual actions installed/implemented in 2025	1.8976
Expected savings from individual actions installed/implemented in 2026	0.5376
Expected savings from individual actions installed/implemented in 2027	0.5376
Expected savings from individual actions installed/implemented in 2028	0.5376
Expected savings from individual actions installed/implemented in 2029	1.0076
Expected savings from individual actions installed/implemented in 2030	2.9976

Table 43: Expected energy savings due to infrastructure projects of the defence sector

Expected end-use energy savings (in ktoe)	Expected annual savings in 2030
Expected savings from individual actions installed/implemented in 2021	0.1134
Expected savings from individual actions installed/implemented in 2022	0
Expected savings from individual actions installed/implemented in 2023	0.5376
Expected savings from individual actions installed/implemented in 2024	0.5376
Expected savings from individual actions installed/implemented in 2025	0.5376

Expected savings from individual actions installed/implemented in 2026	0.5376
Expected savings from individual actions installed/implemented in 2027	0.5376
Expected savings from individual actions installed/implemented in 2028	0.5376
Expected savings from individual actions installed/implemented in 2029	0.5376
Expected savings from individual actions installed/implemented in 2030	0.5376

Table 44: Expected energy savings from defence energy contracts

The defence sector also plans to decrease its building related CO_2 emissions by shifting towards 100 % green energy contracts. To avoid double counting and as green energy could also be imported from abroad, this shift is not considered in OB-B02.

- Emissions factors are standard as in the estimations of other PAMs, that is:

Heating oil (kg/GJ)	Natural gas (kg/GJ)	Electricity (ton/MWh)	Natural gas (t/MWh)
74.10	56.10	0.38[18]	0.20

Table 45 : Description of emission factors

Note: the defence sector assumes an average emission factor of 0.16tCO_2/MWh of primary energy. As this emission factor differs from the emission factors used in this PAMs report, the estimated CO_2 emissions are not the same.

- Allocation factor (to the federal measure) (%): the PAM is strictly federal, so the allocation factor was set to 100%.

3.14.4. Data sources

The data sources used for the estimation of the PAM are presented in the following table:

Measure	Indicators	Source
FEDESCO/Building Agency	Total budget invested in concrete changes to the building (€), submitted PNEC projects	Data transmitted by the Régie des Bâtiments, PNEC project sheets (February 2021)
Defence	Energy Consumption (kWh and l) divided by electricity, gas and fuel Projected energy consumption reductions due to infrastructure projects and energy contracts	Data transmitted by the defence for the energy balances of the three regions. Only the buildings are considered.

Table 46: Description of data sources

3.14.5. Results

In case of the minimum scenario, that investments will stay at the current rate, the annual emission reduction will reach 78 ktCO_2eq in 2050 when a cumulative reduction 2 665 ktCO_2eq will have been reached compared to 2006.

For the max scenario, the annual reduction will reach 135 ktCO_2eq in 2040 and stay stable afterwards. The total amount of GHG emission reduction will reach 3 939 ktCO_2eq in 2050 compared to 2006. According to

[18] Until 2023, see section **Error! Reference source not found.**.

the present report, after 2040, no further investments will be made in the case of the max scenario, but it is likely, that other funding will be approved after 2040.

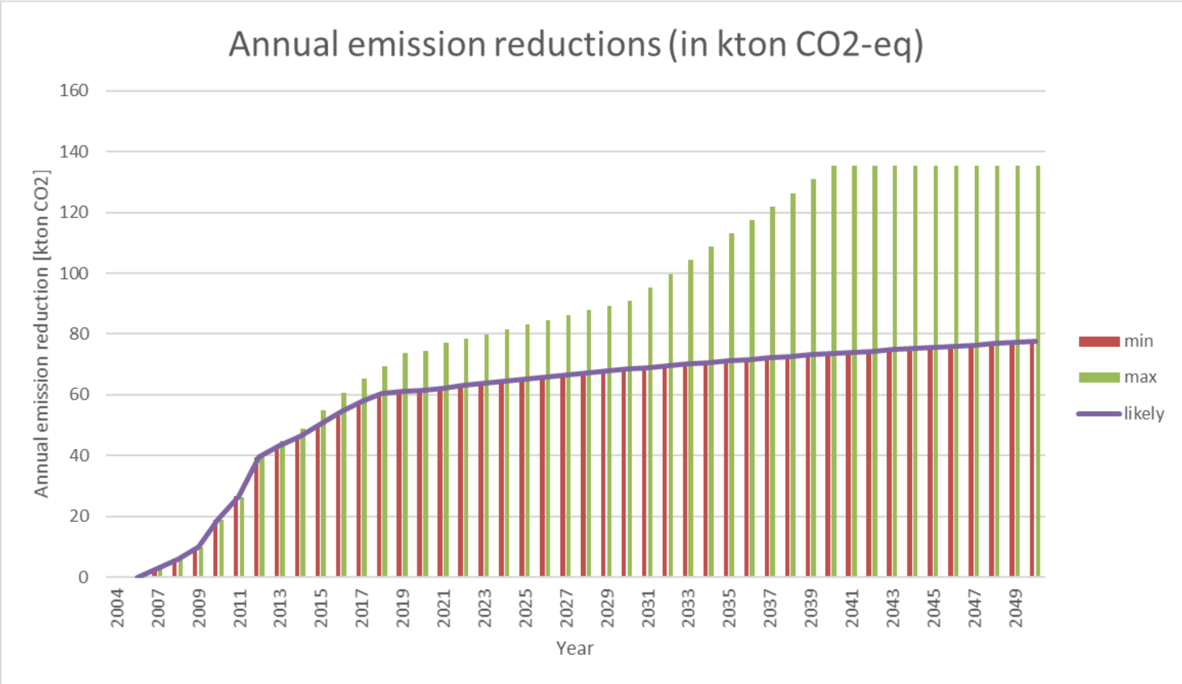


Figure 14: Annual emission reductions (minimum, maximum and likely scenarios)

For the Defence sector the emissions reductions are given in the graph below.

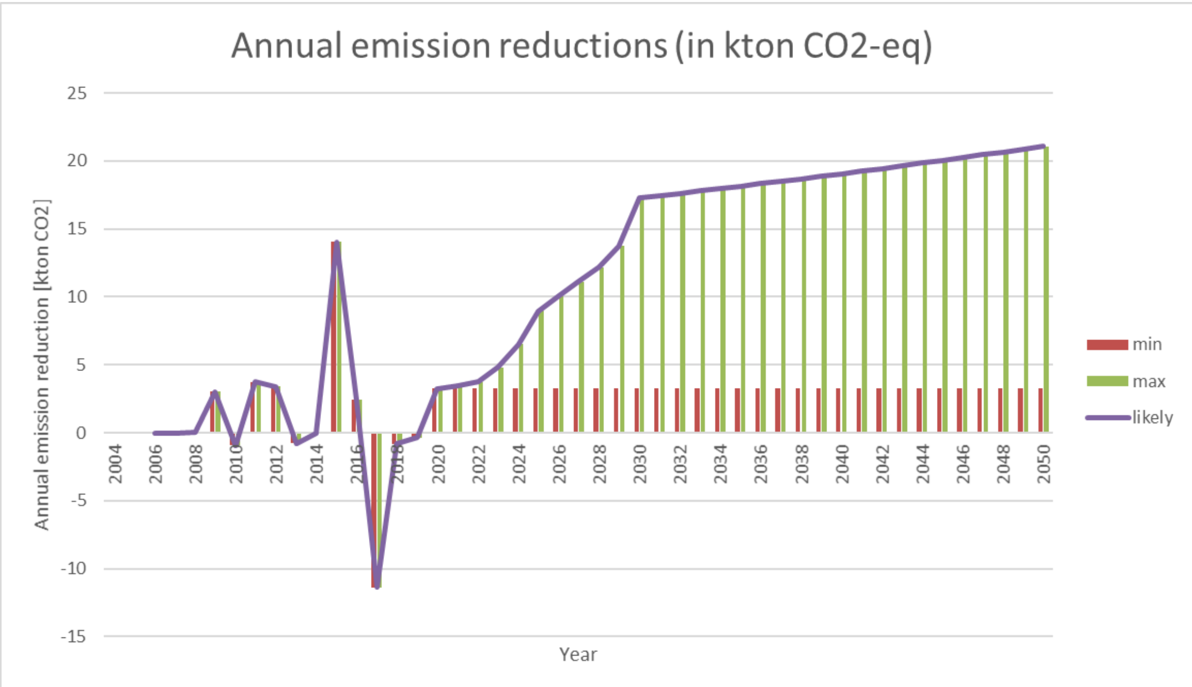


Figure 15: Annual emission reductions of the defence sector

The year of reference of this PAM is 2014. The data submitted from the defence sector indicates yearly emission reductions up to 11 ktCO2/year in 2015 and 2016. After this, came a short period of increased emissions. From 2022 onwards, emissions are supposed to decrease in a rather constant way and to stabilize in 2040 at a reduction of 44.1 $ktCO_2$ per year.

3.14.6. Discussion

The outcome of the emission reduction for the federal building sector depends strongly on the fact how much of the submitted projects will be financed and what the nature of the measures will be. But even with the minimum scenario reductions will increase by almost 1 $ktCO_2$ per year.

For the defence measure, scenarios are based on the scenario submitted by the defence sector until 2030. It is very likely, that these reductions will be achieved.

There can be problems of overlapping with EMAS PAMs. As in the previous assessment (Vito/Econotec 2015), no corrections were foreseen for this problem.

3.14.7. References

- Data transmitted by the Régie des bâtiments (February 2021)
- Data transmitted by the Defence for the energy balances of the three regions.

3.15. OB-C02: Stimulation of alternative modes of transport

3.15.1. Description

All Federal employees benefit from free public transport, to and from work. Some federal public services have a bicycle park for employees to cover small distances. New buildings are preferably built or bought near railway stations.

This PAM results in a reduction of emissions in non-ETS sector.

3.15.2. Methodology and Main Assumptions

The annual emission reduction is calculated by multiplying the extra number of kilometres done by public transport (PT) with the difference in the emissions per passenger-km by PT and car. A formula can express this as follows:

$$ER = \mathrm{NP} \times \mathrm{D} \times \mathrm{WD} \times (\mathrm{EFpt} - \mathrm{EFcar})$$

With:

D	Average distance to and from work (km)
WD	Average annual workdays per year
NP	Increase in number of passengers with tram, bus or metro
EF	Emission factor of PT (average for bus, tram, metro) and car (g/pkm)

The effect of employees using the train to commute to work is estimated under measure TR-A08. For this measure, the reduction in annual CO_2 emissions is estimated for public civil servants using other modes of public transport, i.e. tram, metro and bus. The average distance to and from work is based on the average distance in Brussels, 10 km. We assume that most federal civil servants using public transport (except train) will live in Brussels and closely around Brussels.

The emission factors for tram, bus and metro have been updated with data from STIB, see Table 47. An average of the emission factor of metro, tram and bus is taken.

Emission factors PT (g/pkm)	
Metro	20
Tram	30
Bus	110

Table 47: Emission factors of public transport (PT) in grams per passenger-km. Data from STIB.

The car emission factors have been updated with the latest EF from VITO (VITO, 2019, met aanpassing emissiefactor voor elektrische voertuigen), as well as the number of employees of the federal public services.

3.15.3. Data sources:

- Average annual distance car. VITO-Econotec 2015 evaluation.
- Emission factors tram, bus, metro, STIB. https://www.stib-mivb.be/article.html?_guid=008a3561-2ac1-3410-22bc-d575f8441615&l=en
- VITO, 2019, wagenpark en emissies in het kader van ecoscore en het Vlaamse energie en klimaatplan. BAU-S0REF19 en S2VKP-CPT2017-19, via Marlies Vanhulsel. met aanpassing emissiefactor voor electrische voertuigen.
- Mail exchange with Koen Beirens, FPS BOSA for number of civil servants

3.15.4. Results

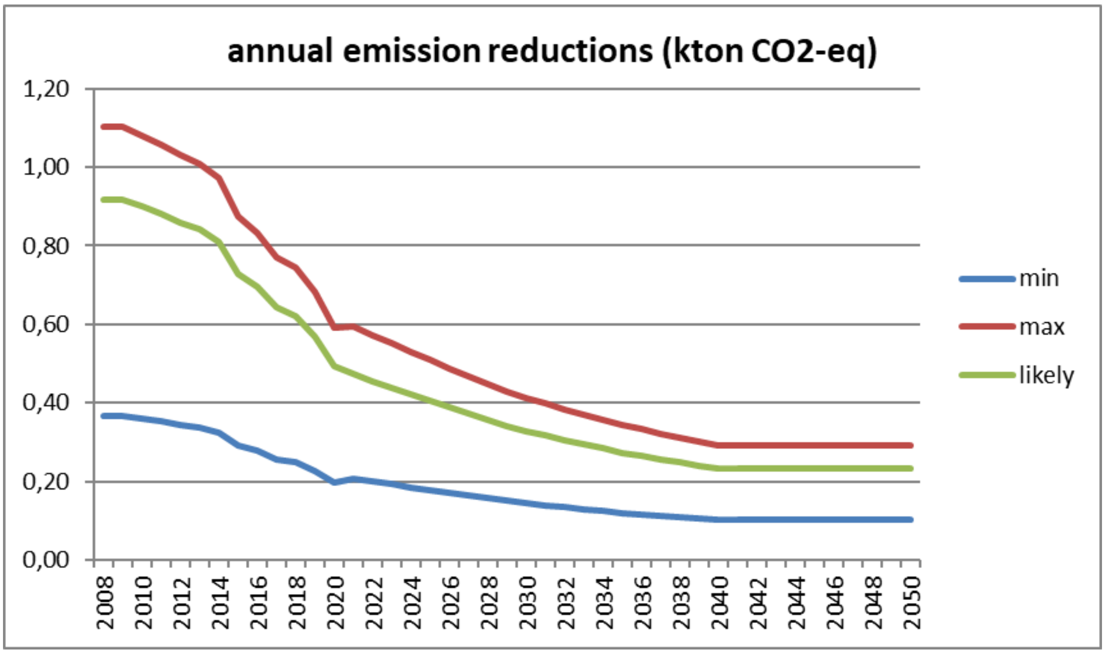


Figure 16: Estimate of the annual emission reduction from OB-C02: Stimulation of alternative modes of transport

3.15.5. Discussion

The results are up to two times higher than the previous reporting as the emission factors of public transport (and cars) have been updated. The reduction in emission reduction is due to the fact that the emissions of public transport are not decreasing while the number of employees in the federal public services is expected to decrease, as are the car emissions.

The constant emission factor for public transport is probably a too conservative estimate with the electrification of buses to come. Therefore, emission reductions could be higher than the estimated ones. However other factors overestimate the impact of the measure. The methodology assumes that each new user of public transport was a car user before. This is a strong overestimation as literature states that individual car use and public transport are generally bad substitutes. This was also discussed under the TR-A02 and TR-A08 policy concerning the promotion of rail transport and free rail transport for commuters. As mentioned under the TR-A08 policy, for rail it is assumed that only 9.8% of commuters would not use the train if it would not be for free. This is probably also the case here, which would mean that the results could be 10 times lower. There are furthermore rebound effects that attract new car users as soon as road capacity is made free by disappearing car users, especially in peak hours.

The methodology from the VITO/Econotec, 2015 evaluation does not count with real world emissions. If real world emissions would have been considered, the effect would have been more important, but still marginal.

All these effects have not been investigated in detail for this measure as its impacts is very marginal.

3.15.6. References

- Emission factors tram, bus, metro, STIB. https://www.stib-mivb.be/article.html?_guid=008a3561-2ac1-3410-22bc-d575f84441615&l=en

3.16. OB-C04: Teleworking for federal civil servants

3.16.1. Description

In a Royal Decree (November 2008) teleworking is allowed for Federal civil servants. A number of federal public services have introduced teleworking for their employees.

The previous assessment (VITO/Econotec, 2015) allocated part of the gains to ETS (rail emissions) and another part to non-ETS (car emissions). We did not follow this methodology as the emissions are extremely marginal and it was not done for previous measures like the promotion of public transport (train) or the free public transport for commuters. Therefore, this PAM results in a reduction of emissions in non-ETS sector.

3.16.2. Methodology and Main Assumptions

The annual emission reduction is calculated by calculating the avoided travel distance by car by the teleworkers. Therefore, average distance, number of teleworkers, number of teleworking days and the average emission factor of a car are multiplied. This can be expressed by the following formula:

$$\text{EF} = T \times D \times DD \times EFcar$$

With:

T	Number of teleworkers
D	Average distance to and from work (km)
DD	Average number of days teleworking per year
EFcar	Average emission factor of a car (kg/km)

We got data via the FOD BoSa (Beleid en Ondersteuning) the number of federal civil servants for the years 2009 till 2020. Concerning the share of teleworkers, we completed the previous time series with figures for 2017-2020.

For the period 2020-2030, we assumed a further reduction in the number of civil servants. Concerning teleworking, we use three scenarios:

- a minimum scenario where number of teleworkers is at 60%, which was the 2019 pre-COVID-19 standard.

- a likely scenario counting with 70% of teleworkers which is a value between the pre-COVID-19 and the COVID-19 level.
- a maximum scenario with 80% of teleworkers which is close to the maximum value during the COVID-19 period of 88%.

Based on data of http://www.pdata.be we also could calculate the average number of days per week that employees worked from home. This was 1.33 days in 2013 (info no longer accessible in 2021). For 2020, we calculated the average number of days of teleworking at 1.54.

The total number of federal civil servants is kept fixed from 2030 on.

Teleworkers traditionally live far from work so we assume that they commute either by car (20%) or by train (80%) and not by other public transport (i.e. bus, tram or metro) or bicycle. Following a study of Verbeke et al. (Verbeke, 2006) the average distance teleworkers commute is 51 km per day.

The initial 2014 estimate did not take into account 2 important indirect effects:

- The increased energy consumption in private houses
- The filling up of freed (mainly car) capacity on the roads by new users

A 2013 study estimates that the positive environmental effect taking into account rebound effects of teleworking is limited. From an energy consumption point of view there would nearly be no reduction. However, as the greenhouse gas intensity of energy sources in transport and house or office heating is lower for the latter, there will remain a positive effect on greenhouse gases. The study expects that 25% of the initial greenhouse gas reduction will remain. Remark that a shift to other transport fuels (gas, electricity) will reduce the 25%. Also, on other pollutants like fine dust, there will remain a positive impact from teleworking. But also here, a shift towards more wood burning in housing will reduce that positive effect (Delhaye. 2013).

In 2017, we integrated the correction for rebound effects and kept only 25% of the initial result.

3.16.3. Data sources:

- Teleworkers in federal administration: http://www.pdata.be/ (no longer accessible in 2021)
- Mail exchange with Koen Beirens, BOSA. Number of civil servants, share of teleworkers
- Emissionfactor: VITO, 2019 wagenpark en emissies in het kader van ecoscore en het Vlaamse energie en klimaatplan. BAU-S0REF19 en S2VKP-CPT2017-19, via M. Vanhulsel met aanpassing emissiefactoren EV (see appendix).

3.16.4. Results

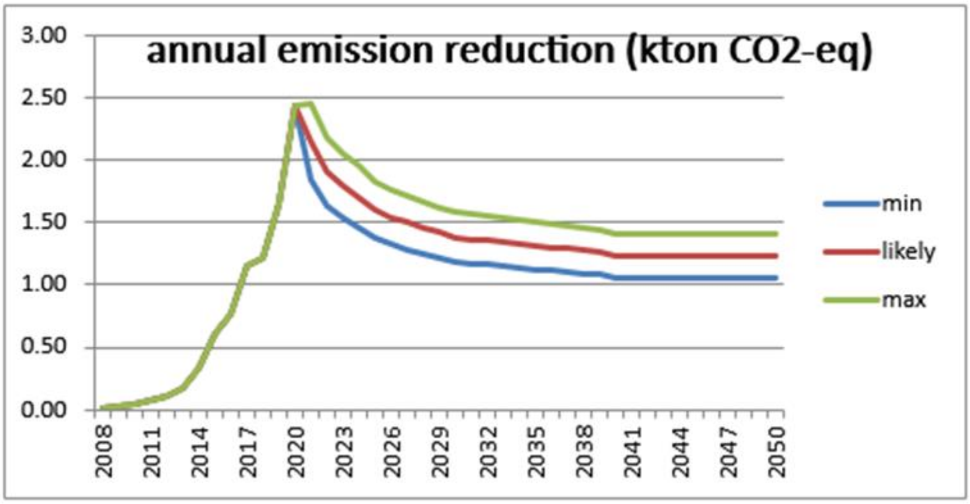


Figure 17: Estimate of annual emission reductions thanks to teleworking

3.16.5. Discussion

The result is higher than the 2014 and 2017 evaluation as there are more teleworkers than expected in the federal administrations. The reduction in gains from 2020 on is due to the decrease in federal civil servants and to a reduction in the average car emission factor.

3.16.6. References

- Verbeke, "De impact van telewerken op de verkeersexternaliteiten in Vlaanderen." VUB, 2006.
- Delhaye, 2013. Reboundeffecten. MIRA.

3.17. OB-C07: Energy efficient cars for federal public services

3.17.1. Description

In 2004, environmental criteria were included in the purchase specifications of vehicles for federal institutions (including federal civil services, federal public and scientific organizations). This was put forward in a circular letter, which stipulates that 50% of vehicle fleet must be conforming the environmental specifications. In February 2008, a revision of the circular letter was requested. The circular letter has been again revised on 21 April 2017. It requests that 5% of the cars purchased or leased are 'green cars' - electric, (plug-in) hybrid or CNG cars - and 10% of the cars purchased or leased have an Ecoscore of more than 75. Most of these 'green cars' have an Ecoscore > 75, but some diesel or petrol cars can have an Ecoscore of > 75 as well. These quotas apply for vehicle fleets of 20 or more passenger vehicles.

The quota are increased by 5% each year. This purchase policy needs to be followed until 25% of the all the vehicle fleets of 20 or more passenger vehicles have an Ecoscore of 75 or more and until 25% of those vehicle fleets consists of electric, (plug-in) hybrid or CNG vehicles. The federal public services with a fleet of less than 20 passenger vehicles had in 2019 a combined share of 5%.

This PAM results in a reduction of emissions in non-ETS sector.

3.17.2. Methodology and Main Assumptions

The same methodology as the one used in the VITO/Econotec. 2015 assessment is used.

$$ER = (EFcar-EFpolcar)*vkm$$

With

EFcar	Emission factor of car without policy
EFpolcar	Emission factor of car with policy
Vkm	Vehiclekm driven

Therefore, we estimate the number of more energy efficient cars ('green' cars and diesel/petrol cars with Ecoscore > 75) at the federal administration thanks to this policy. We then calculate the difference in emission factor per km between the more efficient car and the new car that would be in place in absence of the measure. This per km difference is then multiplied by the km driven by those cars.

The methodology takes following data into account:

- Average annual distance traveled by a car: 21 505 km (VITO/Econotec, 2015 assessment)
- Annual number of energy efficient cars: numbers based on the reporting done by the interdepartmental committee on sustainable development (WAGENPARK 2020)

- Emission factor: VITO, 2019 wagenpark en emissies in het kader van ecoscore en het Vlaamse energie en klimaatplan. BAU-S0REF19 en S2VKP-CPT2017-19, via Marlies Vanhulsel
- VITO calculation (2021).

Based on the reporting from the interdepartmental committee on sustainable development, the following summary can be given:

The total number of passenger vehicles of the federal administration has declined between 2013 and 2019 from 1 156 to 920. This corresponds to a reduction of more than 20%. Between 2017 and 2019 the number of FPS passenger cars reduced by 12%.

In 2019, the total fleet of passenger cars of the federal administration included 920 cars of which 80 cars (or 8.7%) of the 'green type'. In 2013, only a share of 1.4% of 'green cars' were in place. We hereby see that the policy has had its effect. The hybrid petrol cars are the most represented among the 'green' cars but the number of electric, CNG and the plug-in hybrid petrol cars are making inroads in 2018 and 2019.

In 2019, the share of vehicles with an Ecoscore > 75 corresponded to 9%. These 9% includes cars of the 'green type' and diesel/petrol cars with an Ecoscore > 75. A total of 22 petrol cars and 9 diesel cars with an Ecoscore > 75 were in use (overall 31 cars or 3.4% of the total fleet). Based on these numbers we estimate that a total of 111 more energy efficient cars were in use in 2019.

In 2018, 87 new passenger vehicles were purchased or leased, of which 18 'green cars' (21%) and 13 cars with an Ecoscore > 75 (15%).

In 2019, 86 new passenger vehicles were purchased or leased, of which 25 'green cars' (29%) and 37 cars with an Ecoscore > 75 (43%).

In the previous assessment, it was estimated that, since 2008, annually 140 cars are replaced with more energy efficient cars. The reporting from the interdepartmental committee on sustainable development shows that this is an overestimation.

With 8.7% of 'green cars' and 9% of cars with an Ecoscore > 75 in 2019, the federal administration has not yet reached the set target of at least 25% 'green cars' and 25% of cars with and Ecoscore > 75 in the fleet.

Based on these 2019 figures and trends from 2013, we assume for the projections:

- That the overall federal passenger car fleet will continue to decline, not as strongly as over recent years, but by another 4% by 2020. and then by another 5% every 10 years.
- By 2022, 25% of the passenger car fleet will be more efficient energy cars ('green' cars and diesel/petrol cars with Ecoscore > 75). This number takes into account that currently the target is far from being reached, while on average every year 86 cars are being purchased or leased.
- From 2025 onwards, 30% of the passenger car fleet are more efficient energy cars ('green' cars and diesel/petrol cars with Ecoscore > 75). This figure takes into account that most of the Ecoscore > 75 cars will be 'green cars'.

Four emission factors are used in the calculation:

- Emission factor of **baseline**: the average real world emission factor for new cars that would be in place in absence of the policy. This equals the national fleet average. These emission factors are based on the business-as-usual scenario for new cars of VITO (2019).
- Emission factor for **maximum** impact: if all new purchased or leased passenger cars were replaced with the most energy efficient cars, i.e. electric cars, with an emission factor of 0. We see that this is currently not the case, so the possibility of achieving this maximum impact is very low. In reality, the emission factor will not be zero, but equal to the emission factor of the electricity production per kWh. Although we also assume that the emission factor of electric vehicles in the baseline is zero, the emission reductions of the maximum scenario will be an overestimation.
- Emission factor for **likely** impact: more realistic real world emission factor for 'green' passenger cars and petrol/diesel cars with Ecoscore > 75 based on the share of electric vehicles, CNG, hybrid vehicles purchased or leased (see Figure 18) and the share of petrol/diesel cars with Ecoscore > 75.

- Emission factor for **minimum** impact: this scenario follows the likely scenario until 2019 and assumes a constant value of the emission factor of the 2019 share of 'green' passenger cars and petrol/diesel cars with Ecoscore > 75 from 2020 on.

When calculating this average real-world emission factors, it is taken into account that a new car would on average stay 5 years in the fleet.

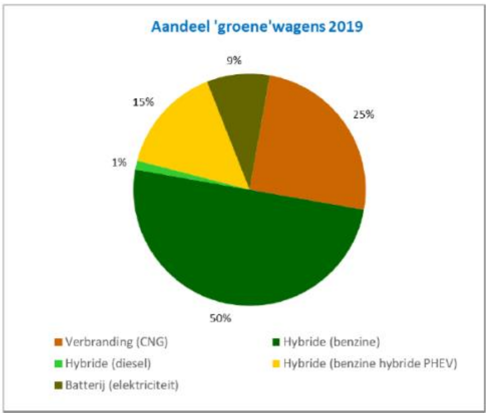


Figure 18: Percentage of CNG, hybrid and electric cars out of the 80 'green cars' in 2019

3.17.3. Data sources:

- Emission Factors VITO, 2019, wagenpark en emissies in het kader van ecoscore en het Vlaamse energie en klimaatplan. BAU-S0REF19 en S2VKP-CPT2017-19, via Marlies Vanhulsel
- Reporting interdepartmental committee on sustainable development: Tweejaarlijks rapport: WAGENPARK 2020 (gegevens 2019) van de federale ICDO-leden, https://www.developpementdurable.be/sites/default/files/document/files/20h_3_7_4_9_rappor tnl_19mei_final.pdf

3.17.4. Results

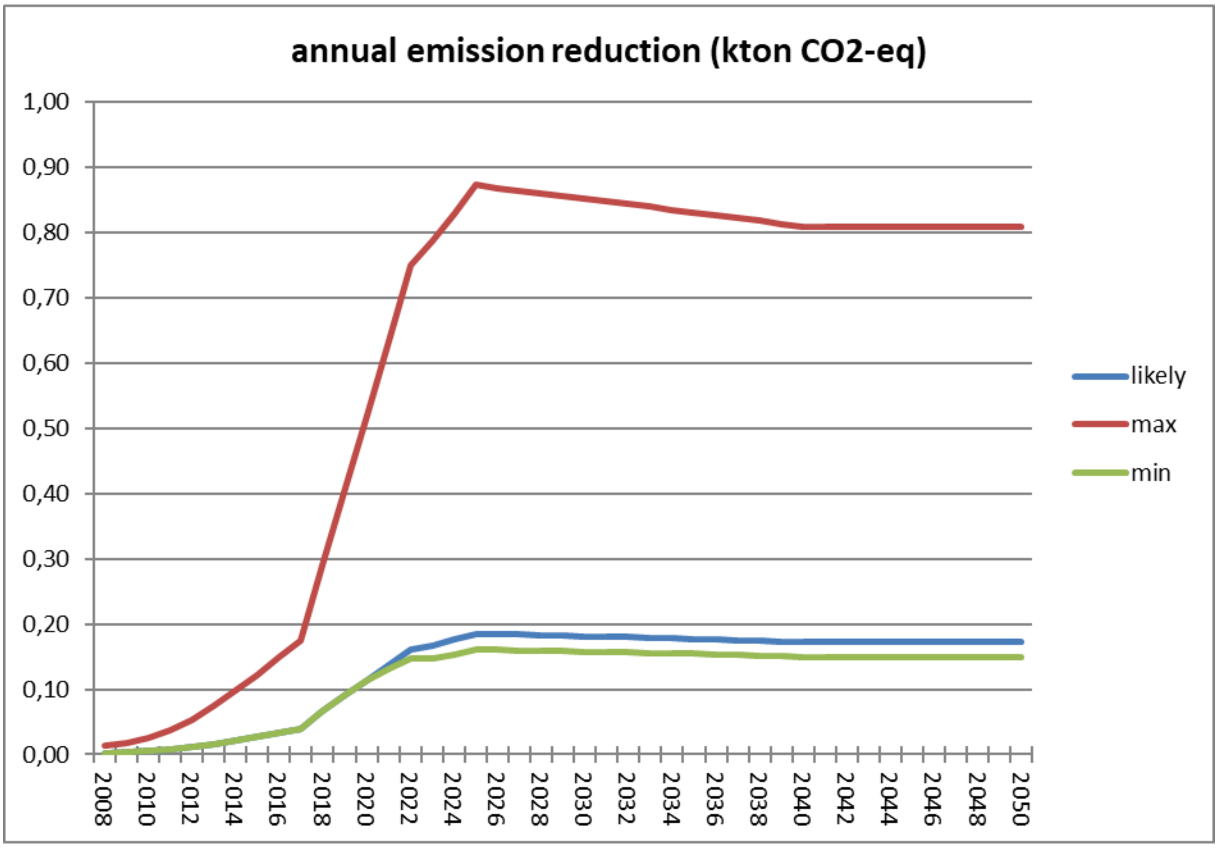


Figure 19: Estimate of annual emission reduction for energy efficient cars for federal public services (ktons)

3.17.5. Discussion

The figure shows the impact of the measure. As was already highlighted in the previous report, the impact is marginal.

For the likely scenario, CO_2 emission reductions only as high as 0.18 ktons of CO_2 can be achieved by 2025 and later years.

For the maximum scenario, when by 2025, 30% of the passenger car fleet of the federal administration are electric vehicles, a maximum of 0.87 ktons of CO_2 can be reduced.

The lower emission reductions after 2025 is due to the assumption that the overall car fleet will be further reduced.

3.17.6. References

- Emission Factors VITO VITO, 2019 wagenpark en emissies in het kader van ecoscore en het Vlaamse energie en klimaatplan. BAU-S0REF19 en S2VKP-CPT2017-19, via Marlies Vanhulsel
- Reporting interdepartmental committee on sustainable development: Tweejaarlijks rapport: WAGENPARK 2020 (gegevens 2019) van de federale ICDO-leden, https://www.developpementdurable.be/sites/default/files/document/files/20h_3_7_4_9_rapportnl_19mei_final.pdf

3.18. TR-A02: Improve and promote public transport

3.18.1. Description

Through Royal Decrees of 29 June 2008, the "management contracts" of the three companies of the NMBS/SNCB group impose a 3.8% annual growth in the number of passengers transported (to achieve 25% over the period 2006-2012[19]), to be reached through investments in infrastructure, the strengthening of the transport capacity and the quality of service (enhancing timeliness, safety, accessibility and information to travelers), the further development of an attractive pricing policy, the promotion of combinations between railway and other soft transport modes through specific investments (parking spaces for cars and bicycles with safety cameras. lighting…) and awareness raising campaigns.

The NMBS/SNCB mentioned following measures that have been taken:

- Measures increasing capacity.
    - 492 M6 coaches (delivery in 2002-2008) 64 000 seats
    - 305 new Desiro triple EMU's (delivery 2008-2014) 85 000 seats
    - 108 new locomotives T18, improved reliability
- Measures increasing frequency with new transportation plan in Dec 2014
- Measures increasing speed around Brussels national airport Zaventem
- Measures increasing comfort
    - New rolling stock
- Improved accessibility of information via apps/website
- Improved system of ticket selling via apps/website
- Gradual introduction of the Mobib card from 2013 on
- Improved connections with other transport modes
    - Bike parking: from 58 703 in 2007 up to 93 432 in 2015
    - Car parking: form 45 949 in 2007 up to 62 766 in 2015

We have no details on further measures from 2016 onwards.

The impact of measure TR-A08 (Free public transport for commuters) is assumed not to be comprised in this measure, as its impact has been estimated separately.

We remark that although some measures were taken to improve rail transport other elements deteriorate the attractiveness of using the train.

- Train travel times were made longer the last years. The FPS could not provide general figures on it, but it is made clear from observation of for example the timetables between Ottignies and Brussels over the last years.
- After some years of improvement between 2013 and 2015 punctuality was worse in 2016 than in 2015, from 89.3% in 2015 to 86.5% in 2016 for the evaluation item "suppressed train included before neutralization". The main reason is the increase in suppressed trains. Still 1 train in 7 is not punctual and in the peak this can increase in the worst case up to 1 train in 4 on the line Brussels-Luxemburg and Mons-Liège7 (Infrabel website https://www.infrabel.be/fr/propos/chiffres-de-ponctualite). The punctuality worsened in 2017 and 2018 but improved in 2019 and 2020 (https://www.belgiantrain.be/nl/about-sncb/themes/ponctuality/ponctuality-archives).
- The foreseen investments of the investment plan 2016-2020 were reduced by 20% in 2016.

[19] This goal achievement will be checked in order to be able to balance the PAM impacts

All the emission reductions are in the non-ETS sector except for the emissions due to the eventual increase in electricity production.

3.18.2. Methodology

We estimate the passengerkm that were done by car previously AND that were shifted thanks to the measures described above. This is a difficult exercise as the measure is rather a collection of vague measures of which the impact is hard to measure.

We then see how much emissions were gained by making the difference between the emission per carkm and trainpkm and multiplying this difference by the number of car drivers that switched thanks to the measure.

The formula below expresses this:

ER = Ntpkm * (EFcar-EFtrain)

with

ER	Emission reduction
Ntpkm	New train pkm thanks to the policy AND previously done by car
EF	Emission factor

The most difficult part in the methodology is to determine the amount of passengerkm that were done by car previously and that were attracted thanks to the measures described above (Nptkm).

Therefore, we start by subtracting the number of commuterkm shifted thanks to the TR-A08 from the total trainpkm.

For the next step we work with different scenarios. The assumptions for the scenarios are given under the assumption section.

The 2014 VITO evaluation states that the increase in passengerkm corresponds to a modal shift from cars to railway on a one-to-one pkm basis. VITO provides however no source for this assumption.

To clarify this point, we did a literature research on the possible switch from car to rail when making rail more attractive. We provide the literature research annexed and the conclusions in the next section.

Based on the information we got, it was impossible to know how exactly the railway offer was improved. We got no resources to investigate more the impact of the different measures. The only measure that improved the quality of the railway offer in a clear and easy to estimate way was the increase in bicycle and car parking. Without clear indications on how the railway offer improved, it is impossible to determine its impact. It is important to take this into account when interpreting the results.

Another critic on the initial VITO methodology is that it takes a constant baseline over the years. It assumed that without the measure, the amount of railpkm would remain the same between 2005 and 2035. This seems unrealistic considering the external environment. In the absence of a clearly defined baseline, we worked with different assumptions and scenarios concerning the baseline (see assumptions) to illustrate the uncertainty.

3.18.3. Conclusions of the literature research on modal shift from car to rail:

As mentioned above, the 2014 VITO evaluation states that the increase in passengerkm corresponds to a modal shift from cars to railway on a one-to-one pkm basis. VITO provides however no source for this assumption. We did a literature research to find information on the potential modal shift from car to rail (see also Section 5.1).

We conclude following based on the literature research:

- While improving train and PT performances, the number of train and PT passengers will increase.

- There will however be only a little part of those new passengers that were previously car drivers.
- There is nearly no evidence from real world experience, that by improving train and PT supply a modal shift from car to rail or PT takes place, except in cases with a significant improvement, much more significant than what was done in Belgium. Available evidence suggests that an attraction of 20 to 30% of car drivers among new train and PT users is a huge success (Savelberg. 2015). Car drivers for whom journey times of PT is not more than 1.5 the car journey time have most change for shifting to train.
- A cross price elasticity between train and car between 0 and 0.1 is probably realistic. This means that by a 10% price decrease of train, 1% of car users on a similar link will switch to train.
- The European BiTiBi project on improving rail services by providing cycle services found that between 40 and 70% of the new railway users would have made the journey by car in the absence of the improved rail service, (BiTiBi. 2016). A more recent study concluded that among new users of a bicycle-train combination (after improving the cycle parking infrastructure), 66% did not make a trip between the same origin and destination. Among those who made a similar trip, 10% where previous car users. The study concludes that discouraging car use and soft measures like incentives at the work location are more effective to attract new rail users (ex-car drivers) (https://fietsberaad.nl/kennisbank/keuze-voor-fiets-trein-is-vooral-ingegeven-door-pr?utm_source=fbnb-032021&utm_campaign=fietsberaadnieuwsbrief&utm_medium=email. https://link.springer.com/content/pdf/10.1007/s11116-021-10165-9.pdf).
- The most effective way to reduce car use is to make it less attractive, by decreasing parking possibilities and make the PT journey time competitive with car and in parallel ensuring enough PT capacity.

Remark:

In their climate emission reporting, the Walloon region counts each extra pkm from public transport as a reduction of one carpkm. They furthermore do not take into account any rebound effect. We did not find any evidence for this assumption in the literature research.

Price elasticities are calculated for a certain range of the demand curve, in other words for price changes of 10% to 20%. This means. conclusions on big price changes, like transport for free, should always be looked at very cautiously.

3.18.4. Main assumptions

A. Assumptions concerning policy impact

Based on the available data and literature, it is very difficult to link the increasing number of rail passengers to a modal shift from car to rail thanks to the railway policy (TR-A02). The improvement in the railway offer is too vaguely described and some factors contributed to a deterioration of the railway offer. So, we cannot link the increase in railkm 1 to 1 to a decrease in carkm.

To consider that uncertainty, we introduce three scenarios with different assumptions on the modal shift from car to rail and different assumptions on the base case:

- **High impact scenario**:

This is a **very unrealistically optimistic** scenario with following assumptions.

100% of all increase in railpkm beyond the commuters travelling for free is there thanks to the policy. 100% of those new railway users would use the car if they could not use the train.

This 100% is far beyond the most positive evaluation we found in our literature research (BiTiBi – Blue-bike, 2016). It does not consider any rebound effect.

There is no rebound effect, this means no cars that disappeared from the road are replaced by new cars.

This means that 100% of new rail users can be considered for CO_2 reductions.

This scenario that does not correspond to a reality. This scenario is included to make the link with the 2014 estimation that took these simple unrealistic assumptions.

- Intermediate scenario:

80% of all increase in railpkm beyond the commuters travelling for free is there thanks to the policy. 50% of those new railway users would use the car if they could not use the train. These 50% are based on the experience in the BiTiBi project (TML, 2017).

40% of road capacity that was made free by car users switching to rail is filled up by other car users. This is a conservative estimate especially when new car users use train in the peak. The rapport "rebound effect met impact op het milieu (Delhaye, 2013 p.53)" made a literature research on this rebound effect (road capacity that is filled up again by new road users). It is unclear how these figures consider the "natural" increase in mobility. This shows that after 3 years, between 50 and 100% of road capacity is filled up by new car users again. We choose here 40% here as we have an intermediate scenario and rebound effects are small in the very short term. In the low impact scenario, we use a higher % of rebound effect.

Finally, **21%** of new rail users can be considered for CO_2 reductions.

- Low impact scenario:

80% of all increase in railpkm beyond the commuters travelling for free and beyond economic growth is there thanks to the policy. Economic growth on its own increases transport demand, also rail demand. This could be considered as conservative as one can argue that without more rail capacity, this growth would not be possible.

25% of those new railway users would use the car if they could not use the train. Literature states that 30% is an optimistic estimate.

75% of road capacity that was made free by car users switching to rail is filled up by other car users. 75% is chosen as the middle between 50 and 100% (based on rapport "rebound effect met impact op het milieu (Delhaye. 2013 p53)").

Finally, **4.4%** of new rail users can be considered for CO_2 reductions.

B. Other assumptions

We consider the growth in railpkm of 1% instead of 2% considered for the 2014 evaluation. The reason is that the observed trainpkm have been stagnating since 2011. The trainpkm without the commutingtrainkm have been decreasing between 2011 and 2016.

From 2030 on we assume there is no growth anymore thanks to the measures in the 2010 -2020 period. Passenger numbers are kept constant.

We assume an economic growth in the future equivalent to that of the past.

COVID 19 impact:

The NMBS provided rail passengerkm for 2020. These show a modest decrease, while other sources mention a more important reduction in rail passengers. The Dutch CPB mentions a reduction of more than 50%. We kept the NMBS provided data.

3.18.5. Data sources

- Past Railpkm: NMBS (Charlotte Dekeyser) and NMBS via FPS Mobility.
  - The 2020 data on pkm were high
- Future railpkm till 2025: NMBS (Charlotte Dekeyser)
- Past economic growth: EUROSTAT website. http://ec.europa.eu/eurostat/statistics-explained/index.php/File:Real_GDP_growth,_2005%E2%80%932015_(%C2%B9)_(%25_change_compared_with_the_previous_year;_%25_per_annum)_YB16.png

- Emission factors:
    - NMBS own calculation base on energy use/pkm (NMBS/SNCB) and CO_2 marginal emission/kwh
    - VITO, 2019 wagenpark en emissies in het kader van ecoscore en het Vlaamse energie en klimaatplan. BAU-S0REF19 en S2VKP-CPT2017-19, via M. Vanhulsel met aanpassing emissiefactoren EV (see annex).

3.18.6. Results

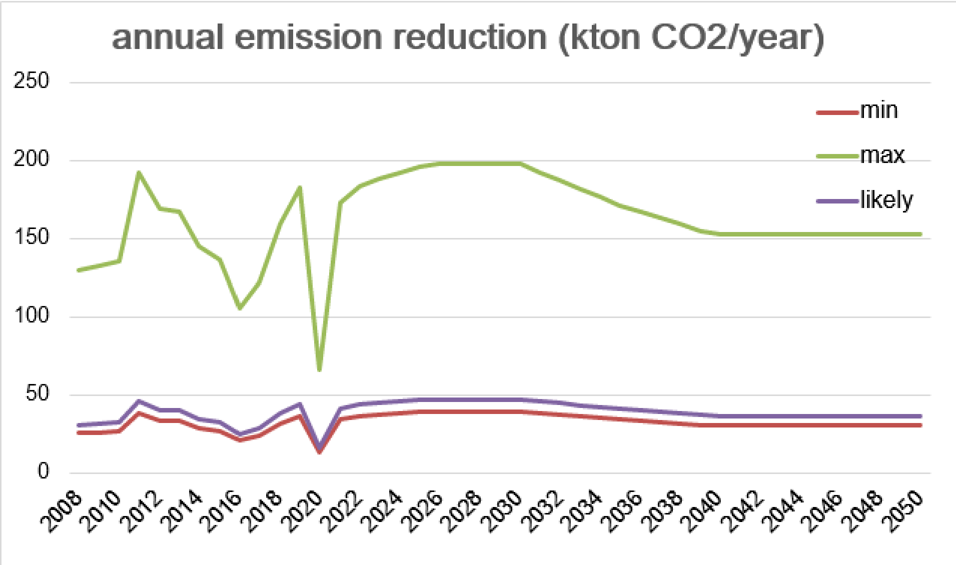


Figure 20: updated estimate of emission reduction thanks to promotion public transport

3.18.7. Discussion

As explained above, it is extremely difficult, maybe impossible to provide a good estimate of the impact of the policy.

We tried to provide an indication of what the impact of the policy could be. We remark in any case that the impact of this policy is decreasing between 2011 and 2017 as the growth in trainpkm in that period is to be attributed completely to free public transport (TRA-08).

In the *intermediate scenario*, the estimated impact of the policy in the early years is between 30 and 50 ktons. In 2020, there is a dip in the impact as rail traffic dropped due to COVID-19. These emission reductions are significantly less than the likely scenario of the 2014 evaluation. After 2020, the impact increases until 2030 and decreases afterwards. The reason for the decrease is double. No new rail passengers are attributed to this policy and the emission factors of cars are getting better with the electrification of the car park.

Compared to the 2017 estimate, the reduction is slightly higher in this estimate thanks to an increase in rail passengers.

Note that for this 2021 evaluation exercise, we considered the indirect emissions of electricity generation of electric cars that will have, following the VITO assumptions behind the emission factors, an important share in the car park. In 2040 the emission reduction is 10 ktons higher if the indirect emissions of EV's are considered (37 instead of 27 ktons).

The impact of the *maximum but unrealistic scenario* is 4 to 5 times larger than that of the likely scenario. As the scenario is unrealistic, it is shown in light colour. The reason is that each new railpkm is counted as carpkm less. This is similar to the 2014 evaluation assumptions.

The *low impact scenario* has a more limited impact as the rebound effect is more important and less rail users are previous car drivers.

A. Impact of bicycle parking

While trying different ways of evaluating this policy, we also estimated the impact of improved car and bicycle parking. We estimated that probably 5 100 extra previous car drivers took the car thanks to this measure. This could be the equivalent of around 13 ktons of CO_2.

We found this result based on evidence we found that 10% of the new bicycle parking users replace their former car journey by train. We assume the same number for users of carparking.

We counted all the new car and bike parkings as new car and bicycle parking users. This is an overestimation as not all parking spots are used.

Over the period 2007-2015 bike parking went up with 35 000 spots and car parking with 16 000 spots. We count this for 5 100 extra train users that were previously car drivers in 2015. 10% of the sum of 35 000 and 16 000.

Taking into account the more general results above however, we need to assume that these extra rail users are mainly free commuters counted under TRA-08 OR that these are compensated by a decrease in other train users.

3.18.8. References

- CBS. Mobiliteit in Coronatijd, 2021 https://www.cbs.nl/nl-nl/visualisaties/welvaart-in-coronatijd/mobiliteit
- Delhaye, 2013. Rebound effecten met impact op het milieu, rapport voor LNE. p53
- Delhaye, 2016. Internalisatie van externe kosten. MIRA
- Van Zeebroeck, 2017. Final report BiTiBi project. EC

3.19. TR-A03: Promote the use of bicycles and pedelecs (APP-T02)

3.19.1. Description

This federal measure has the following components:

- The allowance paid by employers for home-work travel by bicycle is free of tax and social security charges up to 0.15 €/km (Art. 38 of the Income Tax Code). This rate follows the inflation. So it has been raised up to 0.22€/km from 2009, up to 0.23€/km from 2017 and up to 0.24€/km from 2020.
- Home-work travel expenses for using a bicycle are deductible at the lump sum rate of 0.15 €/km (Art. 66bis of the Income Tax Code. applicable from the revenues of 2001). Also, this rate follows the inflation.
- This allowance is also there for pedelecs (APP-T02). Initially, the APP-T02 PAM foresaw a 15% income tax reduction for (speed) pedelecs. As this part of the measure would have had the largest impact and was withheld, it is logic to integrate what remains from APP-T02 PAM in the TR-A03 PAM for this 2021 evaluation.
- The management contract of NMBS/SNCB holding, the company committed itself to the promotion of the use of bicycles, in particular through an objective of steep increase in parking spaces for bicycles in stations, compared to the 59 000 in 2008.

We estimate the impact of the bicycle free tax allowance. The impact of extra bicycle parkings is part of the TR-A02 policy.

This PAM results in a reduction of emissions in non-ETS sector.

3.19.2. Methodology

We work in three steps, first we obtain the extra bicyclepkm since 2005, then we calculate which part of these km are due to the policy and done by previous car drivers (or would have done by car drivers), then we apply the difference in emission factors.

- We want to obtain the increase in pkm travelled by bicycle since 2005:

  Pkmbi =wmodSharebi_hw/wmodSharecar_hw * (hwShareintotalcar * carkmB) * Occ_car

With

Pkmbi	pkm travelled by bicycle
wmodSharebi_hw	Modal share of bicycle in home-work weighted for average home work bicycle
wmodSharecar_hw	Modal share of car in home-work weighted for average home work distance car
hwShareintotalcar	The share of home work travel in total carkm travelled in Belgium
carkmB_hw	driven km in Belgium
Occ_car	The occupancy rate of cars for home-work journeys

- From the extra pkm travelled by bicycle we estimate the part was done thanks to the measure and we estimate what part are ex car users:

Pkmbi_pol = Sharepol*share_excar

With

Pkmbi_pol	The extra pkm travelled by bicycle thanks to the policy (previous calculation)
Sharepol	The share obtained thanks to the policy
Share_excar	The share of ex-car drivers

- We apply the difference in emission factor between car and bicycle:

ER = Pkmbi_pol * (EF car – EF bi)

We remark that we neglected the impact of reduced public transport use thanks to the policy.

3.19.3. Main assumptions

Uptake of cycling thanks to the policy

The initial VITO assessment assumes that all the extra bicycle km are due to the bicycle fee free of tax (see VITO report).

There are a lot of things to say in favor of changing this assumption:

- Modal shift towards bicycle comes more often from bus than from car. Most often, cyclists are in general in only 20% of cases former car users or would have used a car. They are most often former public transport users or pedestrians and probably car poolers. (Van Zeebroeck-TML, 2014)
- Only a part of the people shifting from car to cycle does it because of the fee they get. In most companies paying a fee, other measures in favour of cycling are also applied. The federal diagnostic

observes that companies that introduced a tax-free fee have an increase in the share of cyclists by 1.4%, while companies doing nothing in favour of the bicycle have an increase of 1%, (diagnostic federal 2011 p52). Also, diagnostic federal 2015 (p33) states +34% of cyclists thanks to paying the fee. We take 35% into account.

- The part of companies providing a tax-free fee was not very different in Flanders (88%) compared to Wallonia (76%) and Brussels (77%) in 2015, (diagnostic federal 2015 p29). In 2017, these figures have hardly changed (diagnostic federal 2017, p32). However, the increase in the share of cyclists is very different in the three regions. Between 2005 and 2014, the increase in cyclists was respectively:
    - In Flanders, from 12.3% (2005) to 14.9% (2014) or an increase of 21% and to 17% in 2017.
    - In Brussels, from 1.2% (2005) to 3.0% (2014) or an increase of 148% and to 4.4% in 2017.
    - In Wallonia, from 1.3% (2005) to 1.5% (2014) or an increase of 13% and to 1.6% in 2017.
- The differences in the figures among regions does not proof that the assumption of attributing the increase of cyclists to the one federal policy is wrong. The figures enable us however to assume that other factors than the only tax-free fee play their role in the increasing bicycle use.
    - This observation is reinforced by the fact that although the companies paying a cycle allocation did not change, the numbers of cyclists continued to increase steadily.
- There is a general growth in mobility, so part of the growth in bicycle km comes from this autonomous growth.

Therefore, we take following assumptions:

We assume that only 35% of the increase in cycling is there thanks to the cycling allowance 35% is still an optimistic estimate, although the 2014 evaluation counted with a 100% share. The 35% means that in the absence of the bicycle allowance, one bicycle commuter in three would stop commuting with a bicycle.

We furthermore assume that 20% of the cyclists are former car drivers (Van Zeebroeck, 2014). As the modal shift from car to speed pedelecs is higher than from car to normal bicycles (Mobiel 21, 2014), we assume that from 2020 on, 35% of the cyclists are former car drivers.

Future cycle km

To estimate the future cycle km later than 2017, we assume that cycle use continues to increase till 2030 at the same speed as it did between 2008 and 2017, 19 billion pkm/year. At this pace, in 2030 we assume that around 1000 billion pkm will be driven.

3.19.4. Data sources

- Historical vehkm: statbel and FOD mobiliteit
- http://statbel.fgov.be/nl/statistieken/cijfers/verkeer_vervoer/verkeer/afstand/
- https://mobilit.belgium.be/nl/mobiliteit/mobiliteit_cijfers/kilometers_door_belgische_voertuigen
- Impact of cycle policy in companies: FPS Mobility. Diagnostic federal 2014, 2016, 2019
- Shift from car to cycle: Van Zeebroeck (TML). Fietsen in Brussel, wat brengt het op?, 2014
- Emission factors: VITO, 2019 wagenpark en emissies in het kader van ecoscore en het Vlaamse energie en klimaatplan. BAU-S0REF19 en S2VKP-CPT2017-19, via M. Vanhulsel

3.19.5. Results

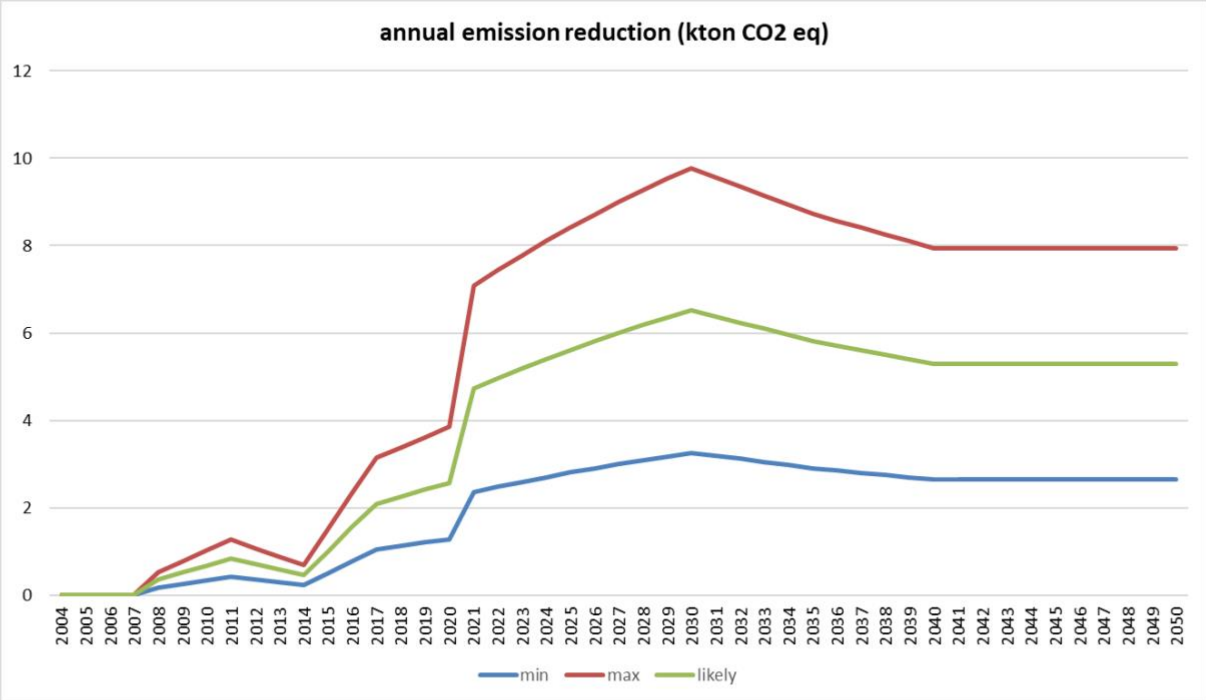


Figure 21: Updated estimate of emission reduction thanks to bicycle use

3.19.6. Discussion

The 2017 and 2021 estimates are lower than the 2014 estimate since not all bicycle kilometres can be taken into account as a result of the measure and as previous car kms. The estimate is however much higher than 7% (35% can be attributed to policy and 20% of cyclists are previous car drivers) of the initial estimate. The reason is that general mobility increased much faster than foreseen in the initial estimate and that the modal share of cycling increased more rapidly than foreseen.

The min scenario is 50% lower than the likely scenario, the max scenario is 50% higher. This can be seen as a scenario where only 10% (or 30%) of the cyclists are previous car drivers until 2020 and 15% (or 45%) after 2020.

There is an increase in 2020 as we assume that with the increased use of (speed) pedelecs, a larger share of the cyclists are previous car drivers. We assumed that 30% instead of 20% are previous car drivers from 2020 on.

From 2030 on, the impact decreases as we assumed no increase in cycling after 2030. As cars are emitting less CO_2, the impact of the policy is also reduced.

The impact is decreasing in the future since cars will emit less CO_2 in future.

We remark however that the result is still an optimistic view of reality as no rebound effect was considered. Rebound effects are indirect effects from the policy. In modal shift policies these effects concern typically the fact that new car users are attracted when road capacity comes available thanks to car users shifting to other modes of transport. It means that the policy effect is not that large as initially expected.

Note that for this 2021 evaluation exercise, we considered the indirect emissions of electricity generation of electric cars that will have, following the VITO assumptions behind the emission factors, an important share in the car park. In 2040 the emission reduction is 1 ktons higher if the indirect emissions of EV's are considered (4.5 instead of 3.7 ktons) for the intermediate scenario.

We were not able to take into account a COVID-19 impact.

3.19.7. References

- FPS Mobility. Diagnostic federal 2011, 2014, 2016, 2019
- Mobiel 21. Het e-fietspotententieel, resultaten online bevraging e-fietspendelaar. 2014
- Van Zeebroeck, 2014, Fietsen in Brussel, wat brengt het op?, Brussel Mobiliteit

3.20. TR-A04: Promote multimodal freight transport

3.20.1. Description

For goods, the development of multimodal platforms occurs through the improvement of river and rail transport (logistics area, infrastructure, investment...). The Federal government has supported the NAIADES programme (2006-2013) of the European Commission to promote inland navigation. This includes fiscal support for the modernization of the Belgian fleet: when selling a vessel, no taxes for capital gain have to be paid if the money is reinvested in a new vessel. For rail, internal intermodal transport (departure and arrival within Belgium) has been supported by federal subsidies from January 2005 until end 2008 (Royal Decree of 30/9/2005, later extended to end 2008). This has been extended from the 01/01/2009 (Programme-Law of 22/12/2008. chapter 3, extended to 30/6/2013 by the Programme-Law of 28/6/2013) and the Council of Ministers of 19/12/2013 has decided to prolong it to 31/12/2014. The aim was to help maintain the existing rail traffic level and to increase it by 20% over a period of three years.

Since 2014, there is also a subsidy for single wagon load transport of goods by rail. It is however very hard to see what the impact of this will be.

In November 2016, the measures were prolonged until 2020.

All the emission reductions are in the non-ETS sector except for the emissions due to the eventual increase in electricity production.

3.20.2. Methodology

We stick to the initial VITO methodology and update the ITU's based on figures form the FPS Mobility. We don't change the baseline. The subsidies are prolonged until 2020. This means the slow trend of less transport via rail is continued.

We update the figures for the years we have new data for, this means until 2015.

ER= Change ITU*t*d*(EFhdv-EFtrain)

With

Change ITU	Increase in number of ITU (intermodal transport units)
T	Average number of tons/ITU
D	Average distance of transport
EFhdv	Emission factor HDV (heavy duty vehicle)
EF train	Emission factor train

3.20.3. Main assumptions

Concerning the measure for single wagon load in place since 2014, we are not able to take its effects into account as this asks a completely other methodology than the actual methodology. It is furthermore very difficult to estimate the impact of it. In a study, TML did for the FPS mobility, it could not define a precise effect (TML 2016).

We assume the impact of the measure will be 0 in 2022 in the absence of a further policy. In 2021, half the reductions of 2020 are taken into account. No future emission reductions have been calculated as these will be treated in a new PAM.

3.20.4. Data sources

- Personal communication with FPS Mobility
- Emission factors: VITO-econotec, 2014 and FPB, 2019, vooruitzichten van de transportvraag in België tegen 2040

3.20.5. Results

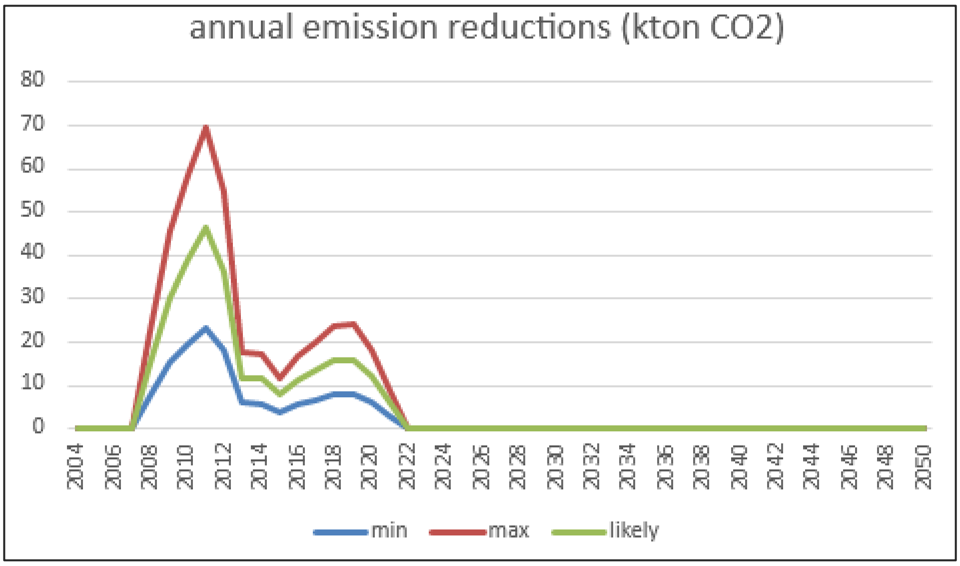


Figure 22: Updated estimate of emission reduction thanks to promotion of multimodal systems for goods

3.20.6. Discussion

The updated estimate of the emission reduction is larger than in the 2014 assessment (VITO/Econotec, 2015) for the beginning of the period. The reason is that the updated figures we got from the FPS Mobility are higher for the years around 2010, than the initial VITO/Econotec figures.

The 2021 estimate is furthermore higher than the 2017 estimate. The reason is that following the FPB transport prognosis, the HDV emissions are not decreasing as initially foreseen. The rail traffic is furthermore not decreasing as fast as initially foreseen.

The reduction in the 2012-2014 period is due to a reduction in the in-port traffic (main hub) and between-ports traffic as well as the international traffic (in 2014 the last subsidy was paid for setting up international connections (mail exchange with FPS Mobility).

From the information we got, it is not sure that without the subsidy the Antwerp-Zeebruges traffic would have taken place by route. (Breemersch –TML. 2016)

We remark furthermore that no rebound effect was considered.

The maximum scenario is 50% higher than the likely scenario. This can be interpreted as that the baseline Is lower than what is foreseen. The minimum scenario is 50% below the likely scenario. This can be interpreted as a baseline that is higher than what is foreseen.

The effect of the PAM gets 0 in 2022. The actual policy stops in 2020 and without subsidy, we assume the effect to become 0 rapidly.

3.20.7. References

- Breemersch et al (TML). Studie over het "level playing field" tussen de vervoerswijzen spoorvervoer, wegvervoer en vervoer via waterwegen met betrekking tot het goederenvervoer. 2016 (vertrouwelijk rapport).

3.21. TR-A08: Free public transport for commuters

3.21.1. Description

TR-A08 and TR-A02 are both promoting public transport. TR-A08 applies only to commuters. We have assumed that TR-A02 applies to all other passengers. Based on new available data related to the commuters the overall impact has been split between TR-A02 and TR-A08.

The federal and regional PAMs to promote modal shift encompass a series of measures like free train service for commuters, extension of the tax deduction for expenses incurred for home-work travel when using alternative transport. … To achieve free public transport by train to and from work for all employees, the Federal government has decided in 2008 to prolong the 80/20 system for private sector employees. It is still applied currently. In this system, 80% of the season ticket of the NMBS/SNCB is paid by the employer and 20% is paid by Federal government. The system of free commuting by train for employees of the Federal government has been permanently extended by a Royal Decree of 3 May 2007.

The simulation below takes into account the fact that:

- the federal government pays 20% of season ticket if the employer pays 80% of the ticket;
- and that the reimbursement is tax free.

It is however important to keep in mind that the federal government provides also tax advantages for people using their car. The advantages are of course much more important for people using a company car.

In the future, it could be therefore interesting to take also a general look at mobility policy and to not only pick out the policies that have a positive climate impact.

All the emission reductions are reductions in the non ETS sector except for the emissions due to the eventual increase in electricity production.

3.21.2. Methodology

We estimate the commuters that would not have taken the train in the absence of the measure. Then we estimate the trainpkm they do and the emissions reduced thanks to it.

We estimate the commuters that would not have taken the train without the measure in two ways:

- We estimate the difference in generalized costs with and without the measure. We do this based on the difference in price experienced by the final user and the cross-price elasticity for car use in function of train price. The cross-price elasticity provides the amount of car users that become train users in function of the change in price.
- We use the result of the simulation done by the federal planning bureau estimating the impact of the measure.

The uncertainty among those estimates is very high, it is therefore important to investigate further the assumptions below.

3.21.3. Main assumptions

A. Assumptions for cross price elasticity methodology

For many commuters, there is a third payment system. Based on the change in price this third payment system causes and the cross-price elasticity, we calculate the number of new commuters thanks to the measure.

We assume the highest long term cross price elasticity of 0.2 that literature provides. This provides a higher end estimate as other literature estimates that cross price elasticity is rather close to 0.

We make a very rough estimate of the generalized price for a 40 km commuter in the table below. The generalized price takes into account the time cost and the monetary cost. The monetary cost the commuter pays is 0 as the government and his employer pay the cost.

The average commuting distance for a car commuter is 20 km, but train is more competitive on longer distances, so we assume shifters to train have on average a longer commuting distance. We assume 40 km on average. Actual train users have an average commuting distance of nearly 50 km.

The upper part of the table shows the actual situation. The lower part of the table shows the situation in the case the government would no longer intervene. This means, the government does not pay any longer 20% of the season ticket (1.4 cent) and the amount paid by the employer is no longer tax free (2.4 cent). Without government intervention, the season ticket would increase by 12%.

	value	source
home work commuting distance (km)	40	OVG
first and last mile (min)	20	
average speed (km/h)	60	MIRA,2016
journey time (hour)	1.0	
value of time (EUR/h)	12.4	MIRA,2016
time cost	12.4	MIRA, 2016
monetary unit price for user/km	0.07	NMBS, MIRA 2016
monetary price	0	commuter doesn't pay
total cost (time+monetary) (EUR)	12.4	
change in situation if government stops interventions		
advantage thanks to fed gov. EUR/km	0.04	Fplanning Bureau
total cost after gov.intervention(EUR)	13.9	
increase in generalised traincost %	**12%**	
increase in fare train cost	unlimited	

Table 48: calculation of average travel cost for commuting and impact of the 20% federal subsidy

When we apply the 0.2 cross-price elasticity on the approximate 12 % price decrease to the car users, it means that 2.4% of car users become train users. The difficult thing is to know on what amount of car drivers we need to apply those 2.4%. It makes no sense to apply the cross-price elasticity to all car commuters in Belgium as for a large majority among those, train is not an option. We make following assumptions to determine the amount of car users we need to apply the 2.4% to:

We consider a transport market where the share of rail and car are rather close to one another. Shares that are close together mean that the transport modes have a competitive position close to one another and that switch between modes can reasonably be expected. We assume 40% rail share and 60% car share. These 60% of car users corresponds to 125 810 car users (83 873 train commuters/0.4*0.6 in 2004). The increase in train commuters thanks to the measure will be 2.4 % or 3 019 in 2004. This figure increases with the number of commuters.

It is clear that these assumptions are not very robust and that in future, further research via surveys and study of statistics is an absolute necessity.

B. Assumptions via Federal Planning Bureau estimate

This means that the total reduction **in pkm thanks to the measure is 9.8% of the trainkm done by commuters with third party reimbursement**. We base this estimate on following information and assumptions:

- on average 50% of train commuters get a third payment reimbursement over the considered period. In 2016, 56% train commuters got a third payment reimbursement (CRB. 2016). 50% will then probably be an overestimation for the first years of the measure and an underestimation for the latter years of the measure, especially for the years beyond 2020. The total amount of commuting pkm by train is reduced by 4.8% due to the suppression of the measure as the simulation of the FPB estimates (Laine, 2016)
- train commuters with third payment reimbursement do on average a similar commuting distance as train commuters without a third payment reimbursement.

It is not clear whether those people would continue to commute without the subsidy or whether they would choose another mode like car or carpooling. Therefore, we introduce two scenarios.

Scenario FPB high

- Estimates that 100% of new rail users thanks to this policy would use the car in absence of the policy. This is an optimistic estimate (see TR-A02).
- Takes a rebound effect of 0% into account. This means that 0 out of 10 rail users that abandoned their car are replaced by another car driver. Especially in peak hours (when commuters use the train), this is not a realistic assumption (Delhaye, 2013).
- This scenario assumes furthermore that not 9.8%. but 50% more or 14.7% commuterpkm less would be made by train if the third payment system would be cancelled.

Scenario FPB low:

- Estimates that 50% of new rail users thanks to this policy would use the car in absence of the policy.
- Takes a rebound effect of 75% into account. This means that 7.5 out of 10 rail users that abandoned their car are replaced by another car driver. (Delhaye, 2013)

C. Future growth in commuters for both scenarios

For 2020-2030, we assume a 2% growth, similar to what was expected in the previous evaluation exercise. We assume no more growth with this measure beyond 2030.

We adapted average daily distance from 70 to 90. On average a (one way) train journey is 50km, however we assume with increasing number of ex car users taking the train, the average train journey will shorten.

3.21.4. Data sources

- People benefiting from third payment system: NMBS/SNCB via FPS mobility
- Emission factors:
  - NMBS own calculation base on energy use/pkm (NMBS/SNCB) and CO_2 marginal emission/kwh

- VITO, 2019 wagenpark en emissies in het kader van ecoscore en het Vlaamse energie en klimaatplan. BAU-S0REF19 en S2VKP-CPT2017-19, via M. Vanhulsel met aanpassing emissiefactoren EV (see annex).

3.21.5. Results

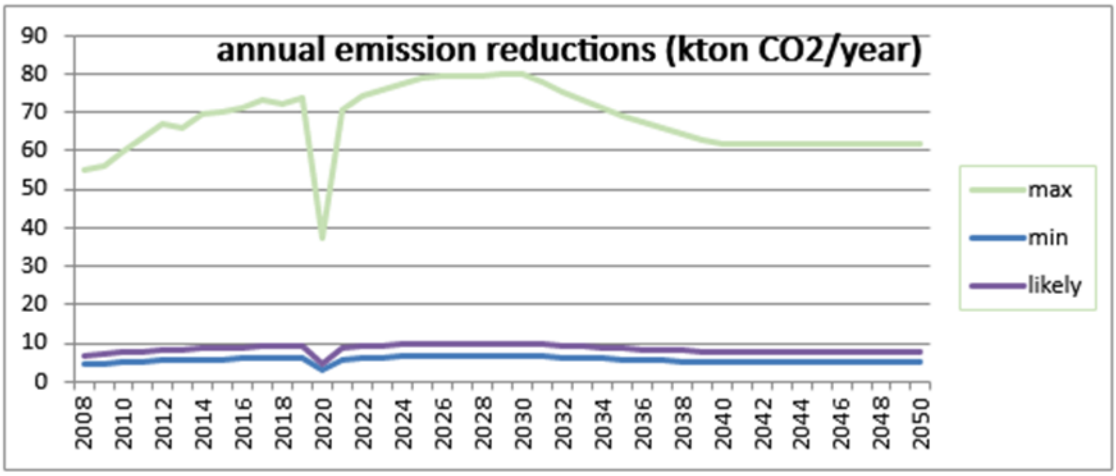


Figure 23: Update of the estimated emission reductions from cheaper commuter transport

3.21.6. Discussion

The emission reductions are significantly lower compared to the 2014 evaluation, except for the max scenario that is close to the 2014 estimate. In 2020, the impact is significantly lower due to the COVID pandemic.

The maximum estimate is unrealistic as it does not consider a rebound effect. This means it does not consider that cars that disappear in the peak period are replaced by other ones. Especially in the peak period, this phenomenon is important (Delhaye, 2013).

The main reason for the reduction in the estimate for the emission reductions is that you cannot assume that each new commuter with a third payment arrangement would not have used the train in the absence of the policy. It is furthermore not sure it was previously a car driver.

The reduction for all the estimates after 2030 is since no growth in the number of commuters is considered and that it is assumed that cars emit less CO_2 in future. From 2040 on further emission reductions from car emissions are assumed.

Note that for this 2021 evaluation exercise, we took into account the indirect emissions of electricity generation of electric cars that will have, following the VITO assumptions behind the emission factors, an important share in the car park. In 2040 the emission reduction is 1.7 ktons higher if the indirect emissions of EV's are considered (7.7 instead of 6 ktons) for the intermediate scenario.

3.21.7. References

- Centrale Raad voor het Bedrijfsleven. Inventaris van de secretariaten met informatie en cijfergegevens die beschikbaar zijn om de huidige kostprijs van het woon-werkverkeer in België te berekenen. 2016
- Delhaye, 2016. Internalisatie van externe kosten. MIRA
- Delhaye, 2013. Reboundeffecten. MIRA
- Laine B. Working Paper 11-16 Commuting subsidies in Belgium. Oct 2016
- NMBS/SNCB, figures on commuters between 2015 and 2019.

3.22. TR-B01: Promotion of carpooling

3.22.1. Description

Carpooling is being supported fiscally. Home-work travel expenses for using carpooling are deductible at the lump sum rate of 0.15 €/km, up to a maximum distance of 25 km (later increased to 50 and 100 km one-way) (Art. 66bis of the Income Tax Code from 2002 - updated in Art. 38 from 2008).

This PAM results in a reduction of emissions in non-ETS sector.

3.22.2. Methodology

To calculate the emissions saved by carpooling we calculate the carkm saved by carpooling thanks to the measure.

- ER = KM carpool* (EF car-EFcarpool)*Corr

With

KMcarpool	Km travelled through carpooling
EF car	Emission factor car (occupancy 1.2, VITO estimation)
EFcarpool	Emissionfactor carpool (occupancy 2, VITO estimation)
Corr	Correction factor TML as not all carpooling is there thanks to the measure

- KMcarpool =Shcarpool*Workers*Distcarpool

With

Shcarpool	Share of carpoolers in large companies (diagnostic fédéral)
Workers	Number of workers (employees + civil servants. not self-employed)
Distcarpool	Average carpool distance (VITO, probably OVG, onderzoek verplaatsingsgedrag)

The number of workers and the share of car poolers have been updated. Both were smaller than in the initial estimate.

3.22.3. Main assumptions

- VITO assumed that all carpool km were done thanks to the fiscal advantage. It will certainly have an impact, but other factors are probably also relevant. For example.
  - if an employer provides information about carpooling, the number of carpoolers is 7 times higher than without the information provision. The same is through for the provision of parking spaces for car poolers (diagnostic federal, 2015, p31)
  - since the introduction of the measure, the number of carpoolers is decreasing. It is unclear what was the situation before the introduction of the measure OR what would have been the situation without the measure.
  - It is unclear what was the previous transportation mode of carpoolers before carpooling. It is probable that part of them used public transport, a bicycle or did not work yet.
- Therefore, we think it is not reasonable to attribute all gains of carpooling to the introduction of the fiscal measure. Based on the previous elements we build three scenarios to take into account the uncertainty.
  - **Likely scenario**: correction factor of 40%. This means only 40% of the carpoolkm can be attributed to the fiscal measure AND were previously done by single car drivers. 40% can

for example be a consequence of 80% of car poolers that are there thanks to the policy and 50% of those were single car drivers before.

- low scenario: correction factor 20%. This means that only 20% of the carpoolkm are there thanks to the policy.
- high scenario: correction factor of 100%. This means that in the absence of the measure no one would carpool and all the previous carpoolers would use their own car. This is an unrealistic scenario that is similar to the hypothesis of the 2014 evaluation.

- We have taken into account a correction factor for rebound effects of 15% as we assume carpooling takes place in places that are less congested than places where trains are an alternative. The rebound effect of 15% means that 15% of avoided carkm are replaced by other cars. For the high scenario, no rebound effect is taken into account.
- We assume also that self-employed do not do carpooling as in most cases it is much more difficult for them organize.
- Beyond 2035 we assumed constant workforce as in 2035.

3.22.4. Data sources

- The share of carpoolers: diagnostic fédéral déplacement domicile travail 2014, 2016, 2019.
- Carpooling distance: VITO-Econotec, 2014
- The number of workers: FPB via SPF emploi
- FPB perspectives économiques http://www.plan.be/databases/PVarModal.php?VC=PRFRESL2&DB=PRF&lang=fr&XT=1
- report of the comité on aging http://www.plan.be/databases/database_det.php?lang=fr&ID=33
- Emission factors: VITO, 2019, wagenpark en emissies in het kader van ecoscore en het Vlaamse energie en klimaatplan. BAU-S0REF19 en S2VKP-CPT2017-19, via Marlies Vanhulsel
- Occupancy rates: VITO-econotec, 2014

3.22.5. Results

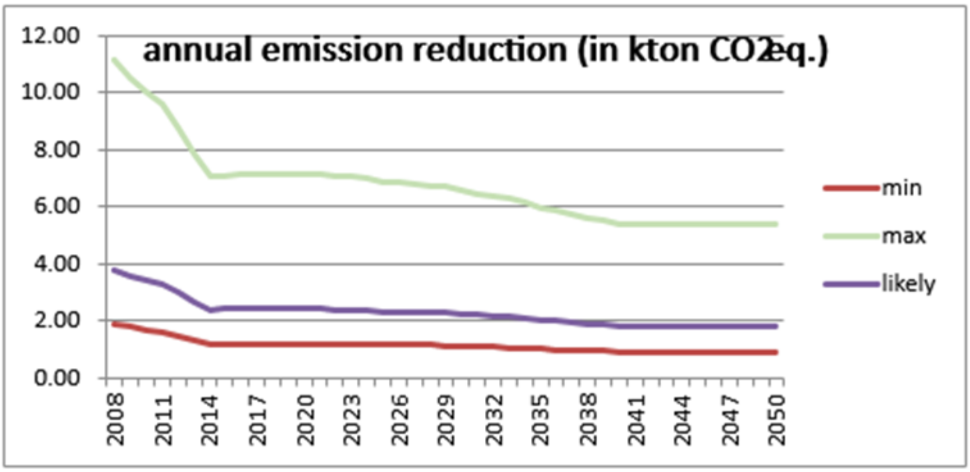


Figure 24: Updated estimate of emission reductions with car-pooling policy

3.22.6. Discussion

The most likely scenario is similar to the 2017 evaluation and lower than the 2014 evaluation. The reason is that we assume that not each carpooler would stop carpooling in the absence of the fiscal incentive.

Based on our assumptions, only 40% of the today carpoolers would stop carpooling in the absence of the fiscal measure.

The maximum scenario takes into account the 2014 assumptions. It assumes that each actual carpooler would use its own car to make the home-work journey. This seems unrealistic.

Independent workers are furthermore not integrated in the workforce as potential carpoolers. The carpooling share is also decreasing more rapidly than foreseen in 2014.

Note that for this 2021 evaluation exercise, we took into account the indirect emissions of electricity generation of electric cars that will have, following the VITO assumptions behind the emission factors, an important share in the car park. In 2040 the emission reduction is 0.4 ktons higher if the indirect emissions of EV's are considered (1.84 instead of 1.49 ktons) for the intermediate scenario.

3.22.7. Data sources

- FPS Mobility, diagnostic fédéral déplacement domicile travail 2014, 2016, 2019.
- Emission factors. VITO, 2019, wagenpark en emissies in het kader van ecoscore en het Vlaamse energie en klimaatplan, BAU-S0REF19 en S2VKP-CPT2017-19, via M. Vanhulsel

3.23. TR-B05 Eco-Driving

3.23.1. Description

This measure on eco-driving corresponds to the application of directive 2003/59/EC, on the initial qualification and periodic training of drivers of driver license categories C (trucks) and D (buses). The latter has been transposed by a Royal Decree of 4 May 2007. It consists in the inclusion of optimization of fuel consumption in the list of subjects of the qualification tests and periodic training for the Certificate of Professional Competence (CPC).

This is different from the eco driving training in the general driving course lessons. The latter is a regional competence, while the organization of the certificate of professional competence is a federal competence.

Since 2015 this measure has been regionalised. Only the Flanders Region puts this measure into practise. The Federal Public Service still exercises this for the other two other regions: the Brussels Capital Region and the Walloon Region.

All the emission reductions are in the non-ETS sector.

3.23.2. Methodology

- Calculation of emission reductions through the following equation:

$$ER = ERrate * EChdv * EFdiesel$$

With

ERrate	Eco driving emission reduction
EChdv	HDV energy consumption
EFdiesel	CO_2 diesel emission factor

- The maximum eco driving reduction is reached in 2016. The maximum level is reached gradually.
- We kept the evolution in diesel consumption constant as VITO did in the initial evaluation.

3.23.3. Main Assumptions

We keep following VITO assumptions:

- Maximal reduction of eco driving is 5.8%.
- Only applicable to 40% of driven km as on motorways there will be no gains of eco driving (VITO).
- There was no effect in 2008. Between 2008 and 2014, the effect increased linearly.

Since 2015, the measure has been regionalised. We therefore assume a linear decline from the impact in 2014 to 0 in 2020. We adapt the assumption on the share of drivers applying eco driving.

Although older literature is quite optimistic on the long run impact of eco driving (4 to 8% for professional category B drivers), recent literature is much more critical. To have a sustained impact over time, it seems to be important to have regular practical training, ideally combined with reminders while driving. If not, the effect fades away after a few months even if there is an incentive repeated after half a year. Theoretical eco drive training does not seem to be effective in any case (see literature sources below).

We therefore assume that the initial VITO estimate is the very maximum that can be obtained. A more realistic estimate is probably half and even less than this. Half means still that 35% of drivers apply eco driving.

We use as the likely estimate 50% of the initial VITO estimate. The maximum estimate is 50% higher, the minimum estimate, 50% lower.

3.23.4. Data Sources

- Diesel consumption HDV: previous VITO evaluation

3.23.5. Results

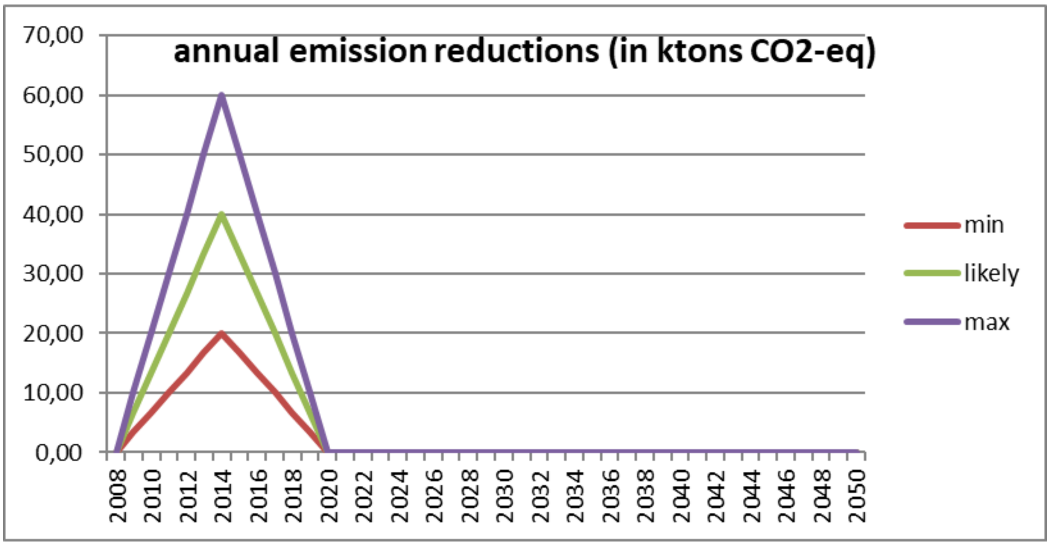


Figure 25: Emission reduction estimate thanks to eco driving between 2008 and 2050

3.23.6. Discussion

The update estimate takes the likely estimate from 2014 VITO Econotec evaluation as the maximum estimate and provides other likely and minimum estimates. As the policy becomes regional policy in 2015, the effect fades out from 2015 onwards. Remark that the increase in total fuel consumption was NOT considered in the initial methodology and we did not change. If we would take the increasing fuel consumption into account, we would have increasing emission reductions at the same rate as fuel consumption is increasing or in other words, the calculated savings would increase while in reality the CO_2 emissions are increasing.

3.23.7. References

- Senternovem Referenced CIECA internal project on Eco-driving in category B driver draining & the driving test (2007), Final Report.
- Barla et al, Eco driving and fuel consumption: impact, heterogeneity and sustainability, Transport Research Board 94th annual meeting, 2014.
- Lauper et al, Psychological predictors of eco-driving: A longitudinal study, Transportation research F, 2015.
- Dominik L, "Do effects of theoretical training and rewards for energy-efficient behavior persist over time and interact? A natural field experiment on eco-driving in a company fleet.", Energy Policy, Volume 97, Pages 291-300, 2016.

3.24. TR-C01: Tax deductions for the purchase of new clean vehicles

3.24.1. Description

This measure concerns private citizen cars:

- From 1 January 2005 till 30 June 2007, the purchase of environmentally friendly cars was promoted via a tax advantage: for cars with a CO_2 emission of less than 115 g/km, 3% of the purchase price could be recovered via a tax reduction and for cars with a CO_2 emission of less than 105 g/km, 15% (with a maximum of 3 280 €) of the purchase price could be recovered.
- From July 2007 to 31/12/2011, this tax reduction (which used to be recovered only after a long delay) has been replaced by an immediate discount on the invoice, of the same amount.
- Additionally, a tax reduction of 150 € is given since 2007 for new diesel cars equipped with a particulate filter, a CO_2 emission of less than 130 g/km and particulate emission of less than 0.005 g/km.
- The Income Tax Code 92 (Art. 145/28) allows a 30% tax reduction for the purchase of electric vehicles and battery recharge installation, from 2010 to 2012.
- For the period 2010-2035, a 15% tax reduction for the purchase of an electrical 4- or 2-cycles has been considered.

We did not consider the adaptation in the deductibility of company cars in favour of electric cars as it does not concern private citizen cars. Taking the adaptation in the deductibility of company cars into account would go beyond a simple update of the policies.

This PAM results in a reduction of emissions in non-ETS sector.

3.24.2. Methodology

We did not change the methodology of VITO 2014.

This means we calculated the emission reductions as:

$$ER = (Nclean\ cars\ policy - Nclean\ cars\ base) * (EFb-EF) * d$$

With

(Nclean cars policy – Nclean cars base) The difference in number of clean cars thanks to the measure (cumulative number of cars with measure minus cumulative number of cars in the baseline)

(EFb-EF) The difference in emission factors/km between clean cars and "normal" cars

D Average amount of km driven per year

We add a correction factor that reduces the impact by 5% as a correction for the fact that the difference between real world and theoretical emissions are bigger for "clean cars' than for other cars (see complementary assumptions below).

3.24.3. Main Assumptions

- The only measure that is still in force is the 15% tax reduction for electrical 4, 3--or2- cycles. VITO estimated the effect too small to consider.
- The number of registered 2-,3- or 4-cycles between 2013 and 2020, vary between 206 in 2014 and 639 in 2019 (see Table 49: Number of registered 2-.3- and 4-cycles between 2013 and 2020
-). These numbers are indeed low and it is unclear if these vehicles replace cars or rather bicycles or public transport or carpooling. It is furthermore unclear how many of these vehicles were purchased thanks to the measure. As VITO in 2014, we therefore estimate this effect to be too small to take into account.

	2013	2014	2015	2016	2017	2018	2019	2020
ELECTRIC MOTORBIKE	45	93	95	103	119	178	446	368
ELECTRIC TRICYCLE		2	1	1	9	10	1	
ELECTRIC QUADRICYLCE	94	111	118	297	144	250	192	154
Total	139	206	214	401	272	438	639	522

Table 49: Number of registered 2-.3- and 4-cycles between 2013 and 2020

- Vito assumed a car is used for 5 years, which is an underestimation as the average car age is 8 year and the lifetime is 18 years (conversation with SPF Mobility). It estimated however also that a car drives 20 000 km/year which is an overestimation. An average car drives between 150 and 200 000km over his life time (Delhaye, 2016). The estimated km are thus only half of the km that are driven in reality over the lifetime of the vehicle. Instead of adapting in depth the calculation method, we only adapt (double) the yearly km driven to 40 000 instead of 20 000 km. This means the impact is overestimated at the beginning of the period and underestimated at the end of the period as we assume 200 000 km (5*40 000) driven during the first 5 years, 0 km during the next years. Over the whole period however, the estimated mileage corresponds to reality.
- We assume that the number of cars registered under this policy measure did not evolve since the VITO evaluation.
- The baseline, however, has been re-estimated based on the EEA database of CO_2 emissions for newly registered cars.
- The EEA database provides all new registered vehicles including their CO_2 emissions.
- The table below provides the number of cars in the category <105 and between 105 and 115 g. For the <105g there is a clear reduction in sales between 2011 and 2012. This is very probably due to the abolition of the measure. There has however been an exceptional increase in the sales in 2011, probably, due to announcement of the abolition of the measure. The decrease between 2011 and 2012 is therefore probably overestimated. A more "normal" registration figure for 2011 seems to us 145 000, this is 25 000 units above the 2010 figure. 25 000 units is the "normal" growth figure of that market in the years 2012-2015.

Year	<105 g	105-115g
2010	118 299	64 544
2011	167 285	69 512

2012	95 422	77 412
2013	121 169	93 263
2014	141 534	
2015	166 028	

Table 50: registrations of vehicles with official CO2emissions <105 gr and between 105 and 115g (EEA. http://www.eea.europa.eu/data-and-maps/data/co2-cars-emission-11)

We assume a normal "reduction" in sales between 2011 and 2012 of around 50 000 unit, from 145 000 to 95 000 or a relative reduction of nearly 35%. We will take this reduction as the effect of the abolition of the policy, or in other words, 35% of the vehicles sold between 2005 and 2011 have been sold thanks to the measure. For the first years 2005 – 2007, this is probably an overestimation as people got the reduction only via a reduction on their income taxes. The 35% effect is also considered as a rather high estimate by people of the FPS Sustainable mobility as lots of other factors influence car sales like the economic situation, the amount of models available, … It was not possible to take all those latter factors into account in the simple analysis.

For the vehicles in the 105-115 class, no real effect of the policy can be observed.

We limit ourselves to the effect of the <105 vehicles.

- VITO-Econotec (2014) did not use real world emission factors but theoretical emissions from test cycle for its simulation. We know however that real world emissions are much higher than theoretical emissions. VITO-Econotec (2014) assumed implicitly that the difference between real world emissions and test cycle emissions are similar for "clean" and "normal" cars. In that case the absolute difference between both "clean" and "normal" cars is the same for real world and test cycle.
- However, since "clean" cars obtain the biggest reductions in emissions when driving rather slowly, while in practice, vehicles drive relatively more at higher speed than in the theoretical cycle foreseen. The Dutch research institute TNO assumed in 2010 following relation between emission factors in theory and in practice (see table below). For a diesel car with a test cycle emission of 130 g/km, the real-world emission is 169g/km for a diesel car and 167 for a gasoline car.
- Based on this table we assume that for a 140 g/km test cycle emission, the real-world emission is 177 g/km or 37 g/km more than the test cycle. For the "clean low level" 100g/km emission, the real-world emission is 142, the difference is 42g/km. This means, VITO assumes an emission reduction of 40 grams where the emission reduction is only 35 grams, on overestimation 5g/km or 12.5%. For the "clean middle level" clean car the difference is 4g/km less or 10%.

Normwaarde CO_2 [g/km]	Praktijk diesel [g/km]	Praktijk benzine [g/km]
160	193	188
130	169	167
100	142	142

Table 51: Difference between standard and real-world emissions depending on the standard emission value

- On the other hand, the emission factors of "normal cars" didn't decrease as fast as expected as the EF of the car park remain constant at 168 between 2008 and 2013 while VITO took into account a reduction of the emission factors of the "normal cars". We therefore assume prudently that the overestimation is only 5% instead of 10%. The correction factor could be further detailed for each year, but this is beyond the scope of this exercise.

- VITO did not expect an increase in the increase of sales of "clean middle level cars" beyond the increase due to the measure. It would probably have been reasonable to consider a higher increase in the baseline for the sales of these type of vehicles. We did not do this as this would go beyond the scope of this study.

We did not take into account any rebound effect while there is probably one as the measure makes car driving cheaper.

3.24.4. Results

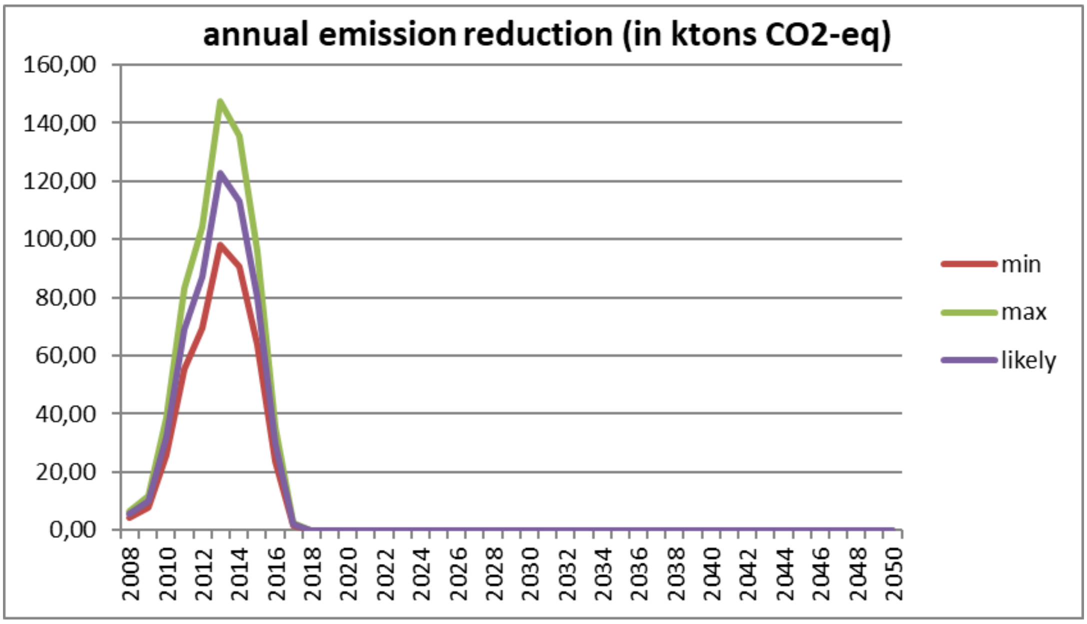


Figure 26: Update of the emission reduction estimate thanks to TR-C01: Tax deductions for the purchase of new clean vehicles

3.24.5. Discussion

The differences between the VITO Econotec 2014 estimate and the TML 2017 estimate are due to an initial overestimation of the impact of the measure. Thanks to the difference in registration with the measure or without the measure in 2011 and 2012, we estimated the impact for the < 105 g vehicles. The impact was nearly only one third of the initial estimate. This was partly compensated by the increase in estimated vehkm.

The impact of both estimates is too much concentrated in the indicated period. There is also still an impact in the later years as a car lifetime is longer than the estimated 5 years. The total impact is however correct as we increased the yearly mileage.

The 2021 estimate did not change the previous estimate.

3.24.6. Data Sources

- Ligterink (TNO). CO_2 uitstoot van personenwagens in norm en praktijk – analyse van gegevens van zakelijke rijders. 2010.
- Delhaye, 2016. Internalisatie van externe kosten. MIRA
- Sold vehicles: VITO, probably FPS Finance or Mobility.
- Emission factors: VITO-Econotec

- Number of 2,-3,4-cycles: FPS Mobility (Marc Kwanten)

3.25. TR-D01: Promoting biofuels

3.25.1. Description

The biofuel policy is based on following Belgian legislation:

- Law of 17-07-2013 concerning minimal volumes of sustainable biofuels in fossil fuels. A modification of this law is in preparation with a view to achieve the 2020-goals.
- RD (Royal Decree) 21 July 2016 on the minimal required volumes of sustainable biofuels in gasoline. It foresees 8.5 volume % of bioethanol (5.7% energy)
- RD 26-11-2011 on biofuels, which sets environmental criteria (energy efficiency, GHG balances), agriculture (use of pesticides and fertilizers), proximity (shortest distance between production biomass and production unit), etc.).
- RD transposing Council Directive (EU) 2015/652 of 20 April 2015 laying down calculation methods and reporting requirements pursuant to Directive 98/70/EC of the European Parliament and of the Council relating to the quality of petrol and diesel fuels.

At European level, the European renewable energy directive (the original Renewable Energy Directive (2009/28/EC) (RED) was recast in December 2018 to Renewable Energy Directive 2018/2001/EU (RED II)) and the European fuel quality directive set a framework for the use of biofuels. The Federal government puts a biofuel policy in place to decarbonize transport in this framework.

We estimated the impact of the biofuel content of fuel as provided by the FPS Health, Food Chain Safety and Environment as we assume without policy no biofuels would have been used (precise % of assumed biofuels are provided below).

We use different scenarios to estimate the impact as explained below.

Last years, different reports critical for the environmental impacts of biofuels came out. Especially the Globium study (Ecofys, 2015), commissioned by the EC is very critical for the environmental impacts of biofuels and biodiesel due to the impacts of indirect land use changes.

We are fully aware of the fact that life cycle greenhouse gas emissions will not have to be reported in the transport sector under the UNFCC framework. However, we think that it is important to be aware of what the impact of a biofuel policy can be on global greenhouse gas emissions.

Emissions of biofuels exist while producing biofuels, but also due to changes in land use. Changes in land use can cause extra greenhouse gas emissions. For example, if for producing biofuels, (tropical) forest needs to be destroyed or if land for food production is used for biofuel production and that food production needs new land for which (tropical) forest needs to be destroyed.

None of these direct (production) and indirect (land use change) emissions needs to be taken into account in the UNFCCC reporting for the Belgian transport sector. The land use changes take place outside Belgium, the production of biofuels can take place in Belgium or not. In the case of Belgian production, it is reported in another sector, if not produced in Belgium, it is not reported by Belgium. Internationally, allocation of responsibility for reducing greenhouse gas emissions is currently based on the production-based accounting method, which measures emissions generated in the place where goods and services are produced (this approach is applied for inventory and for identification of reduction potential of PAMs). However, it is important to be aware of the impact of a biofuel policy on global greenhouse gas emissions, outside the country, this is illustrated in the section 'indirect impacts'. Considering those indirect impacts would imply using totally different accounting methods (using consumption-based approach) also for the national inventory.

We therefore add a (very) simple estimate of what the impact of the Belgian biofuel policy is when taking into account those direct and indirect emissions. However far from perfect, this estimate will provide a global view [closer to reality than the official reporting].

This PAM results in a reduction of emissions in non-ETS sector.

3.25.2. Methodology

Formula:

$$ER = C_g * (EF_g - EF_{bg}) * B_g + C_d * (EF_d - EF_{bd}) * B_d$$

With

C_g	gasoline consumption (PJ)
C_d	diesel consumption (PJ)
EF_g	CO_2 emission factor of gasoline (kt/PJ)
EF_d	CO_2 emission factor of diesel oil (kt/PJ)
EF_{bg}	CO_2 emission factor of biofuel replacing gasoline (kt/PJ)
EF_{bd}	CO_2 emission factor of biofuel replacing diesel (kt/PJ)
b_g	biofuel content of Gasoline (energy share)
b_d	biofuel content of Diesel oil (energy share)

The formula shows that the emission reduction thanks to biofuels is the share of biofuels in the fuels for transportation multiplied by the difference in GHG emissions per unit (EF or emission factor). The emission factor for biofuels is 0 under the UNFCCC framework but is different from in the real world, due to production and land use change emissions.

We start from total energy consumption in the transport sector and make a division between diesel and gasoline. The energy consumption is based on figures from the Federal Planning Bureau for the years 2000-2016. From 2017 onwards, figures were taken from the recently published study “BIOBRANDSTOFSTUDIE IN HET KADER VAN HET NATIONAAL ENERGIE-KLIMAATPLAN - N°USD67370” from SIA PARTNERS, for the years 2020, 2025 and 2030. The numbers were interpolated for the years in between.

The SIA PARTNERS study expects a 29% decrease in energy consumption for the entire fleet of vehicles with internal combustion between 2020 and 2030. Furthermore, an increase in the use of petrol vehicles and a decrease in the use of diesel vehicles between 2020 and 2030 explains the observed increased gasoline energy consumption and reduced diesel energy consumption.

Road transport fuel consumption (TJ)			
		Gasoline	Diesel
2000		100800	222737
2001		98151	236594
2002		93706	241613
2003		94514	248777
2004		85175	270484
2005		77542	265766
2006		64207	270871
2007		61019	276616
2008		63504	306266
2009		60802	305395
2010		54982	314528
2011		55441	311071
2012		51759	288150
2013		51939	284620
2014		51206	286283
2015		50473	287945
2016		49740	289608
2017		54876	281262
2018		60013	272916
2019		65149	264570
2020		70285	256224
2021		72081	246826
2022		73878	237428
2023		75674	228030
2024		77470	218631
2025		79266	209233
2026		78294	198675
2027		77321	188117
2028		76349	177559
2029		75376	167002
2030		74404	156444
2031		74404	156444
2032		74404	156444
2033		74404	156444
2034		74404	156444
2035		74404	156444
2036		74404	156444
2037		74404	156444
2038		74404	156444
2039		74404	156444
2040		74404	156444
2041		74404	156444
2042		74404	156444
2043		74404	156444
2044		74404	156444
2045		74404	156444
2046		74404	156444
2047		74404	156444
2048		74404	156444
2049		74404	156444
2050		74404	156444

Table 52: Energy use in transport sector based on data from the Federal Planning Bureau (until 2016) and the SIA PARTNERS study (2020,2025 and 2030)

For the years 2018 to 2020, FPS Health, Food Chain Safety and Environment provided the amount of litres of biofuel, from different feedstocks, consumed in Belgium. From 2021 onwards, the share of biofuels will be based on the goals set out in the National Energy and Climate Plan (NECP), which follows the goals set out by the European Commission.

From this biofuel share, we estimate the GHG emission gain. This is the difference between the emissions of the biofuels burnt and the emissions of the fossil fuels that would have been burnt if no biofuels had been burnt.

For the previous evaluation (TML, 2017), 3 scenarios were set with different possible biofuel and second-generation biofuel shares by 2020 and 2030. For this reporting period, the NECP scenario is taken into account as the likely scenario, see Figure 27. A minimum and maximum scenario is included which assumes a 20% reduction and a 20% increase respectively of this likely scenario.

1G stands for first generation biofuels, produced from crops such as cereals, sugars and oilseeds. Part A and Part B biofuels are biofuels produced from raw materials belonging to Part A of Annex IV and Part B of Annex IV of the revised Renewable Energy Directive 2018/2001. Examples of Part A feedstocks are Animal manure and sewage sludge straw, nut shells etc. Examples of Part B feedstocks are used cooking oil and animal fats.

Biofuels	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Actual value	8.95	8.95	9.25	9.55	9.8	10	10.2	10.45	10.45	10.45	10.45
1G	7	7	7	7	7	7	7	7	7	7	7
Part A	0.1	0.1	0.1	0.1	0.1	0.5	0.5	1	1.5	1.75	1.75
Part B	1.85	1.85	2.15	2.45	2.7	2.5	2.7	2.45	1.95	1.7	1.7
Double counting	0.6	0.6	0.95	0.95	0.95	2.2	2.2	2.7	3.2	3.45	3.45
Nominal value	9.55	9.55	10.2	10.5	10.75	12.2	12.4	13.15	13.65	13.9	13.9

Figure 27: Table from the NECP, giving the actual and nominal biofuel share for 2020 to 2030. For the emission reduction calculations, the actual values are used.

The table below shows the biofuel shares considered for the different years. For the 2008-2014 years, and the 2018-2020, the shares are the observed shares. For the years 2015-2017, these are assumed shares. For 2020-2030, these are the goals set in the NCEP. Concerning the distribution between bioethanol and biodiesel:

- In 2017 the energy share of bioethanol is 5.7%. The biodiesel share is chosen to reach the average biofuel share indicated in the table below. From 2018 to 2020 the bioethanol and biodiesel shares are taken from the data provided by FPS Health, Food Chain Safety and Environment
- In 2030 a bioethanol share of 14% is taken. The biodiesel share is chosen to reach the average biofuel share indicated in the table below.
- In the period between 2020 and 2030 the bioethanol share is linearly interpolated between the 2020 and 2030 value.
- The shares of advanced Part A and Part B biofuels are taken from the NECP (see Figure 27) between 2020 and 2030, and taken from the data provided by FPS Health, Food Chain Safety and Environment between 2018 and 2020. After 2030 these values are kept constant to the 2030 value (3.45%).

3.25.3. Main assumptions

The main assumptions we make concern:

- The biofuels shares from 2015 to 2020 are based on estimations by FPS Health, Food Chain Safety and Environment. From 2021 onwards, the share of biofuels is based on the goals set out in the NECP (Figure 27). The figures we use for energy use for the years beyond 2030, we assume same figure as for 2030. The SIA PARTNERS study doesn't provide figures beyond 2030.
- The iLUC emissions as provided by the Globium study increase from 0 in 2008 to their value in 2020. The Globium study models the iLUC impacts of EU policy around 2020 taking into account the additional biofuels produced since 2008 in EU and the rest of the world. We assume therefore, these iLUC will appear completely in 2020 because of the EU policy (and other countries policies). We assume that in previous years, the iLUC changes were lower as less biofuels were produced and competition for land was less strong. We assumed the LUC emissions 0 in 2008 increasing up to the results of the Globium study in 2020. This is probably a conservative estimate as probably already in 2008 LUC emissions were present.

year	biofuel share
2008	1.19%
2009	3.65%
2010	4.16%
2011	4.09%
2012	4.22%
2013	4.24%
2014	5.02%
2015	5.28%
2016	5.40%
2017	5.53%
2018	6.10%
2019	6.20%
2020	8.50%
2021	8.95%
2022	9.25%
2023	9.55%
2024	9.80%
2025	10.00%
2026	10.20%
2027	10.45%
2028	10.45%
2029	10.45%
2030	10.45%
2031	10.45%
2032	10.45%
2033	10.45%
2034	10.45%
2035	10.45%
2036	10.45%
2037	10.45%
2038	10.45%
2039	10.45%
2040	10.45%
2041	10.45%
2042	10.45%
2043	10.45%
2044	10.45%
2045	10.45%
2046	10.45%
2047	10.45%
2048	10.45%
2049	10.45%
2050	10.45%

Table 53: Energy share of biofuels as provided/assumed by FPS and NECP (2008-2014, 2018-2020 real world shares – 2021-2050 assumed shares)

3.25.4. Data sources

Life cycle emissions:

- Gasoline and diesel: fuel quality directive (Directive 2015/652 20-04-2015 p35 and following).
- Production and transportation of biofuels: renewable energy directive (RED) (Directive 2009/28/EC 23-04-2009 p58 and following)
- Advanced biofuels: renewable energy directive and Globium study (Ecofys, 2015)
- ILUC emissions: the Globium study ((indirect)Land use change impact of biofuels consumed in the EU. study for EC. Ecofys, 2015)

For the biofuel components:

- Actual biofuel mix: FPS Economy, DG Energy and FPS Environment

Energy use:

- Federal Planning bureau (personal communication) until 2016
- SIA PARTNERS study for the years 2020, 2025, 2030

Emission factors car:

- VITO, 2019 wagenpark en emissies in het kader van ecoscore en het Vlaamse energie en klimaatplan. BAU-S0REF19 en S2VKP-CPT2017-19, via M. Vanhulsel met aanpassing emissiefactoren EV (see appendix).

3.25.5. Results

The annual CO_2 emission reductions due to the PAM TR-D01, for the 3 scenarios, are shown in Figure 28:

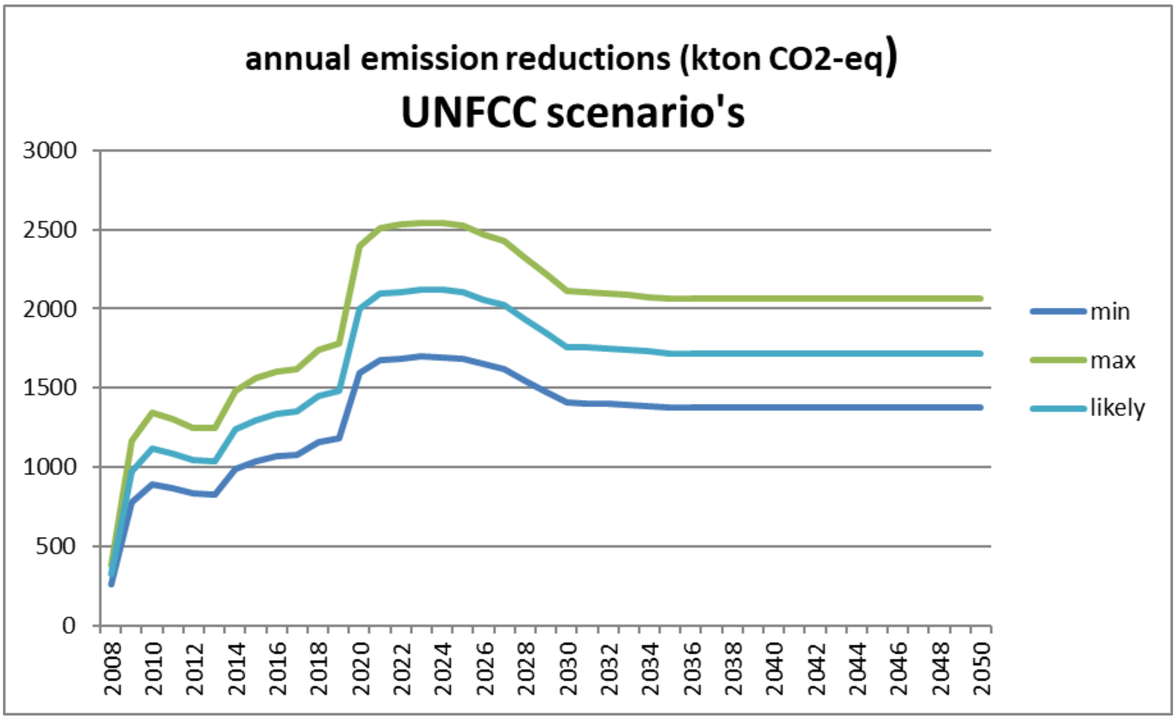


Figure 28: Annual emission reductions thanks to biofuels (UNFCC scenario)

Year	Likely UNFCCC scenario	Year	Likely UNFCCC scenario	Year	Likely UNFCCC scenario
2008	321	2023	2 120	2037	1 720
2009	972	2024	2 118	2038	1 720
2010	1 117	2025	2 104	2039	1 720
2011	1 088	2026	2 059	2040	1 720
2012	1 042	2027	2 020	2041	1 720
2013	1 036	2028	1 934	2042	1 720
2014	1 235	2029	1 847	2043	1 720
2015	1 299	2030	1 759	2044	1 720
2016	1 333	2031	1 753	2045	1 720
2017	1 349	2032	1 746	2046	1 720
2018	1 450	2033	1 738	2047	1 720
2019	1 483	2034	1 730	2048	1 720
2020	1 995	2035	1 720	2049	1 720
2021	2 092	2036	1 720	2050	1 720
2022	2 108				

Table 54: Overview of emission reduction in kton for the likely UNFCCC scenario

Results of the world impact scenarios

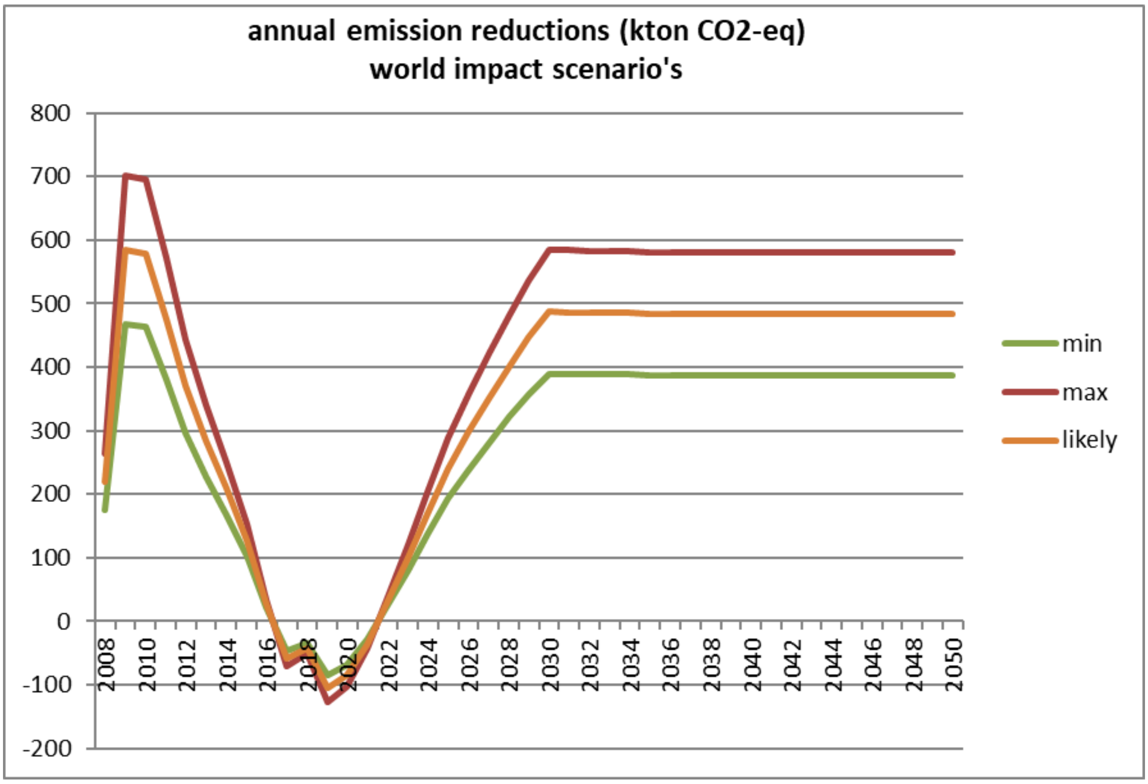


Figure 29: annual emission reductions thanks to biofuels (world impact scenario)

Year	Likely world impact scenario	Year	Likely world impact scenario	Year	Likely world impact scenario
2ss008	220	2023	100	2037	484
2009	584	2024	170	2038	484
2010	579	2025	240	2039	484
2011	477	2026	297	2040	484
2012	370	2027	351	2041	484
2013	283	2028	402	2042	484
2014	209	2029	447	2043	484
2015	127	2030	487	2044	484
2016	28	2031	486	2045	484
2017	-59	2032	486	2046	484
2018	-42	2033	486	2047	484
2019	-106	2034	485	2048	484
2020	-86	2035	484	2049	484
2021	-36	2036	484	2050	484
2022	32				

Table 55: Overview of emission reduction in kton for the likely world impact scenario

3.25.6. Discussion

In 2020, the gain of the biofuel PAM was 1995 ktons of CO_2, in line with scenario 2 of the previous 2017 evaluation (see Table 54). By 2025, the gain is expected to be 2104 ktons of CO_2, and by 2030, 1 759 ktons of CO_2. This reduction after 2025 can be explained by the reduced overall road transport fuel consumption.

The world impact scenario starts from the same assumptions concerning biofuel shares as the UNFCCC scenarios. Those world impact scenarios take however also the indirect emissions (production and land use change) into account. Those take most of the time place in other parts of the world and other sectors and are not part of the Belgian transport emissions. These emissions are however present and contribute to climate change. Therefore, it is interesting to have a look at those results.

The figure above shows that the world impact of biofuels is significantly lower than what the UNFCCC reporting shows.

In 2020, CO_2 reductions were negative at 86 ktons (see Table 55). This means that the biofuel policy increased the emissions of CO_2 instead of reducing it. The UNFCCC reporting reports a reduction of 1995 ktons of CO_2.

Only after an increased share of advanced biofuels are used, we observe a reduction in CO_2 emissions. In 2030, the reduction is 487 ktons of CO_2 compared to 1759 ktons of CO_2 in the UNFCCC scenario.

The scenarios make it clear that first generation biofuels increase global climate emissions while advanced biofuels will probably have a positive climate impact. The impact of advanced biofuels needs however to be closely monitored as few practical experiences on large scale production of advanced biofuels is available.

3.25.7. References

- Ecofys, 2015. Globium study (indirect) Land use change impact of biofuels consumed in the EU. EC

3.26. TR-XXX: Advantage in kind depending on CO_2 emissions for company cars

3.26.1. Description

Employees benefiting from a company car are taxed on the value of that advantage in kind. A formula determines the value of the advantage in kind in the personal income tax declaration of the employee.

On 01/01/2012, a new formula determining the advantage in kind for company cars was introduced taking into account the theoretical CO_2 emissions of the car. The previous formula did not take into account CO_2 emissions. The reference CO_2 levels are fixed each year by royal decree. The advantage can never be below 820 EUR/year (base amount – 1 340 in 2020).

The parameters of the formula are adapted each year to keep an incentive for choosing lower emission cars. The table below illustrates the calculation for the year 2017.

	formula to calculate emissions in kind (2017)
Diesel	(5.5%+(CO2-87) X 0.1%) X official price X 6/7
Gasoline	(5.5%+(CO2-105) X 0.1%) X official price X 6/7
Elektricity	(4% X official price X 6/7

Table 56: formula to calculate emissions in kind (2017) with "CO2" corresponding to the official CO_2 emission of car in g/km (https://finances.belgium.be/fr/particuliers/transport/voitures_de_societe)

The table below shows the emission references used for the formula. Note that from 2018 on, the reference emissions do increase.

Reference Emissions (gr CO_2/km)		
Year	Petrol	Diesel
2012	115	95
2013	116	95
2014	112	93
2015	110	91
2016	107	89
2017	105	87
2018	105	86
2019	107	88
2020	111	91
source: SPF Finances, 2020, voitures de sociétés. FAQ.https://finances.belgium.be/sites/default/files/downloads/121-faq-voitures-de-societe-2020-20200327.pdf		

Table 57: Overview of reference values to calculate advantage in kind of company cars

This PAM results in a reduction of emissions in non-ETS sector.

Remark: also, the fiscal deductibility of (company) cars influences very probably the employer car choice.

Since the previous 2017 evaluation some changes occurred:

The deductibility is limited to between 50 and 100% and to 40% if the car emits more than 200 g CO2/km. Electric cars benefit no longer from a 120% deductibility from 1-01-2020 and fake plug-in hybrids have a particular regime.

Since 2021, the CO_2 reference value cannot increase, in order to avoid that the advantage in kind would decrease with increasing CO2 emissions.

The company (moral person) can deduct 60% or 83% of the advantage in kind depending on whether the company pays the fuel of the car. If it pays the fuel, only 40% can be deducted. This rule is in place since 2017. Also, this measure probably reduces CO_2 emissions, it was however not considered a PAM to be evaluated here.

3.26.2. Methodology and main assumptions

Two important steps need to be taken to determine the impact of the measure:

- Determine the impact on the per km CO_2 emissions of newly registered company cars based on an analysis of the evolution in CO_2 emissions/km
- Determine how many km these cars drive during all their lifetime. and how many CO_2 emissions can be avoided. The latter is done via the formula :

$$ER = vkm*SHleg*(EFbc-EFpol)$$

With

Vkm	Total km driven by cars
SHleg	Share of legal entity cars
EFbc	Emission factor base case

EFpol	Emission factor with policy

We detail further those steps.

A. Determine the impact of the measure on the per km CO_2 emissions of newly registered company cars

Based on observation of the evolution in CO_2 emissions of the newly registered company cars we want to see whether we observe evolutions that would not have been there without the measure. We can only guess what would have been the emissions without the measure. Therefore, we try to see:

- how CO_2 emissions of company cars evolved in other years compared to 2012, the year of introduction of the measure. We consider the period 2008 – 2016, as well years before as years beyond 2012 as we the major impact should be visible in 2012 itself.
- how CO_2 emissions of non-company cars evolved in the same period to see whether company cars evolved in different way thanks to the measure between 2008 and 2016.

This exercise is however very challenging as

- different measures to orient the choice of company cars towards cleaner company cars have been taken previously:
  - From 01/01/2005, the solidarity contribution paid by the employer for providing a company car to its employee is determined depending on the theoretical CO_2 emissions.
  - From 01/04/2007 the deductibility for cars bought by legal persons is dependent on theoretical CO_2 emissions (memento fiscal 2008 p69). From 1-01-2010 the dependency on CO_2 emissions of the deductibility of cars bought by legal persons is strengthened. (Belgian national policy framework. Part 5 federal level Belgium (draft), 2016).
- Non company cars got incentives to choose for lower emitting cars. This implies that comparison with the other category becomes difficult:
  - From 01/07/2007 the fiscal incentive for clean vehicles bought by natural persons is immediately reduced from the invoice, and not only one year later via the taxes (memento fiscal 2008 p36). This measure was abandoned on 31-12-2011, coinciding with the introduction of the measure we are investigating here.
- Separate data on CO_2 emissions of newly registered company cars are not available for a long enough period.
  - Only from 2013 we got data for company cars, while the new measure was introduced on 01/01/2012. Therefore, we use the cars of legal persons as a proxy although only approximately 1/3 of newly registered cars of legal persons are company cars. Note that due to a reorganization at the FPS Mobility, specific figures on salary cars are no longer available for the latest years neither.

All these above elements are reasons to consider this exercise with caution. This was the case in 2017 and is still the case in 2021.

The table below illustrates the data used. The yellow years correspond to years when a measure with an objective of reducing CO_2 was applied.

The first part of the table shows the evolution of the **theoretical CO_2 emissions** of newly registered cars for natural persons (in g CO_2/km), legal persons and company cars for the years 2013, 2014 and 2015. The company cars are part of the legal person's cars. The source for this information is the databases of the federal planning bureau. (no longer accessible in 2021)

The line "absolute evolution" shows the absolute CO_2 reductions in grams/km from one year to another for legal entity cars (emissions in g/km of year x - emissions in g/km of year x+1).

The lower part of the table shows the same type of information for **real world emissions**.

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
theoretical emissions (databases FPB)										
natural person	152.7	149.7	149.3	144.6	139.7	131.1	123.5	130.1	126.4	124.2
legal person	162.1	161.7	158.4	153.9	149.1	139.9	133.6	124.9	120.8	118.1
salary car									115.0	111.7
absolute reduction in emission legal person		0.4	3.2	4.5	4.8	9.2	6.4	8.7	4.1	2.7
real world emissions										
natural person	174.1	167.7	171.7	169.9	167.7	159.9	154.4	162.7	164.3	168.9
legal person	184.8	181.1	182.2	180.9	179.0	176.3	173.7	168.6	169.1	171.2
salary car									161.0	162.0
absolute reduction in emission legal person		3.7	-1.1	1.3	1.9	2.6	2.7	5.0	-0.5	-2.1

Table 58: overview of theoretical emissions (FPB database) and real-world emissions (ICCT factors applied) in g CO_2/km

We estimated real world emissions based on the ICCT report From Laboratory to Road, 2015. We applied the deviation for company cars of the ICCT report to the legal person car registrations. This is for sure another exercise that needs to be considered with caution as we apply average EU deviations to Belgian figures. It's sure that those figures can be much improved. On the other hand, it is important to realize that emission reductions are not that important as one could think. Deviations between theoretical and real-world emissions are provided below.

difference between real world and theoretical (Laboratory to road 2015, ICCT) in %										
natural person	14	12	15	17.5	20	22	25	25	30	36
company car	14	12	15	17.5	20	26	30	35	40	45

Table 59: % difference between theoretical CO_2 emissions and real-world emissions as derived from the ICCT report form Laboratory to Road. 2015

The graphs below present the data of Figure 30:

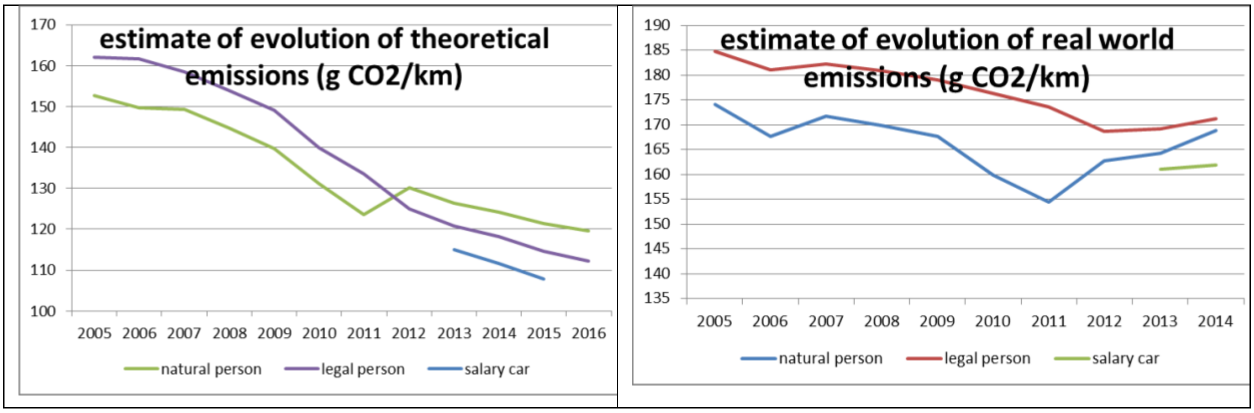


Figure 30: evolution in theoretical (left) and real world (right) CO_2 emissions per km of different types of cars (g/km)

We observe clearly that real world emission reductions in CO_2 per km stopped somewhere around 2011 – 2012. Natural person's cars start even to emit more than before.

The *theoretical* emissions of legal person cars are getting lower, more rapidly than that of natural person cars. In 2012, the legal person cars do even get cleaner than the natural person cars. The main reason for natural person cars to start emitting more is probably the abolition of the subsidy (tax reduction) for the purchase of a clean car for natural persons. It is also the time when the new calculation for the advantage in kind for company cars comes into place.

For the *real-world* emissions, we also see that legal person and natural person cars are getting closer one to another, but natural person cars remain however cleanest. We have unfortunately no data beyond 2014 on the deviation between real world and theoretical emissions.

To estimate the impact of the new calculation method determining the advantage in kind for company cars we finally look at the average evolution in emission reduction in the years where no new measures had been taken and compare it with the emission reduction for legal cars in 2012. We do this first based on the theoretical emissions, then based on the real-world emissions.

- The average theoretical emission reduction of the years 2008, 2009, 2011, 2013, 2014, 2015 and 2016 is 4.1 g CO_2/km. The improvement in 2012 is 8.7 g CO_2/km. This would mean that the measure "advantage in kind" is responsible for an additional reduction of 4.6 gCO_2/km. (8.7-4.1 = 4.6)
- If we apply the same method for the real world emissions we arrive at a reduction of 4.3 g CO_2/km.
- The estimated impact of the policy (around 4.5 g CO_2/km) is very similar between the calculation based on real world emissions and the one based on theoretical emissions.

This seems to be a number that is on the high side as it means that the emissions from company cars are reduced by approximately 12.5 gCO_2/km only thanks to the policy. This estimate of a 12.5 gCO_2/km reduction for company cars is based on:

- the facts that company cars represent 36% of the cars registered by legal persons
- the fact that legal person cars as a whole reduce their emissions by approximately 4.5 g CO_2/km.
- the assumption that the whole of this reduction can be attributed to company cars, and not to the other legal cars, as no policy is in place for these other cars.

This seems an important effect keeping in mind that the impact on the company of the new calculation of the advantage in kind is not that important. Based on some simple examples we see that the calculation of the advantage in kind comes with a value of approximately 20 EUR gross wage per gram of CO_2. For 10 g CO_2/km difference between cars, the advantage for the employee is then 200 EUR gross wage or 100 EUR net each year. It is strange that people let influence their choices so strongly for a 100 EUR/year they get only later.

An explanation for this high result (12.5g) is maybe that employers also encourage employees to choose for the low emitting car as it is also in their interest.

In 2017, we tried to see how emission figures influence preferences for company cars of the compact middle class (C-segment). We however did not find the data to make this exercise in a sound way. We provide this 2017 exercise as an indication.

- We found a list of popular company cars for 2015 but unfortunately not the 2015 emissions of those cars.
- We considered as a proxy for the 2015 CO_2 emissions for these cars, the 20017 theoretical emissions. Theoretical average emissions of Renault Megane were 98 in 2017, for VW Golf, 108 and for the Peugeot 308, 96. The difference in emissions is max 12 g.
- While looking at the 2015 popular company cars we observe that the Renault Megane (13775 sales) is most popular, but the VW Golf (8193 sales) remains popular. The low emitting Peugeot 308 (4874 sales) is less popular.
- This is not what we would expect if the calculation of the advantage in kind would have a real impact.
- However, as already said above, this is a dangerous exercise as we compare emissions of 2017 with popularity figures of 2015. It could however also be an indication that the estimated impact of 12.5 g reduction thanks to the measure seems at the rather high side, as low emitting cars are not necessary more popular than high emitting cars.

It is clear that to come up with more robust estimates, a more detailed analysis is an absolute necessity. This is impossible in the framework of this study.

We take the 4.5g CO_2/km gain as an upper bound of the measure and as a lower bound we take 2.5 g CO_2/km but more research is necessary to confirm these figures.

B. Determine how these newly registered cars are used during all their lifetime

To see how the reduction of CO_2 emissions of newly registered cars influences total CO_2 emissions, we need to know how the km driven with these cars evolves. Therefore, we use the information on vehicle stocks and km driven used by the regions to calculate their emission inventories. We have used those data in a simplified/aggregated form. Those data are not publicly available but can be obtained from the regions. This aggregation work is however labour intensive. For this reason, these figures have not been updated for the 2021 estimate. Another reason, for not putting this effort in updating these figures, is that the 2020 government declaration foresees a big change in the fiscal regime of company cars.

To determine the CO_2 reductions, we assume furthermore that:

- 47% of new car registrations are done by a legal persons (based on federal plan bureau data http://www.plan.be/databases/data-14-fr-base+de+donnees+transport)
- the per km reduction thanks to the measure is 4.5 g CO_2/km between 2012 and 2025 for the upper bound (maximum) and 2.5g CO_2/km for the lower bound (minimum) (section above).
- the impact for new cars is reduced in the years after 2020, respectively 3 and 1.5 g CO_2/km for the years 2021-2024, 2 and 1 g CO_2/km for the years 2025-2028, 1 and 0.5 g for the years 2029-2032, and 0.5 and 0 for the years 2033-2035. The reasons therefore are that decreasing effect are:
  - the estimated effect seems really high end.
  - mobility and vehicles will need to undergo strong changes in the future. We assume therefore that it will be difficult to keep similar effects of the measure if it is not profoundly adapted.
- The company cars are sold to Belgian citizens once they are too old to be a company car. This means, the emission gain of the initial company cars has an effect during the whole lifetime of the car, also when it is no longer a company car.

As there is high uncertainty in the estimates, we prefer not to come up with a likely scenario. This would only provide a wrong impression of likeliness.

3.26.3. Data sources

- Average theoretical per km CO_2 emissions: number of newly registered cars in each emission category with a difference between vehicles of physical persons and legal persons from the Federal planning bureau http://www.plan.be/databases/data-14-fr-base+de+donnees+transport
- Difference between real world emissions and theoretical emissions: ICCT. From laboratory to road, 2015 and update 2018.
- Formula to determine advantage in kind: SPF Finances. Nouvelles règles de calcul et FAQ. Avantage de toute nature résultant de l'utilisation à des fins personnelles d'un véhicule mis gratuitement à disposition par l'employeur/entreprise.
- Vehkm per vehicle age class: Vehicle stock Database for the emission calculations by the regions (available from regions) calculated in 2016, not in 2021.
- Most popular company cars in 2015: http://www.jobat.be/nl/artikels/de-20-populairste-bedrijfswagens-van-2015/

3.26.4. Results

The figure below illustrates the results:

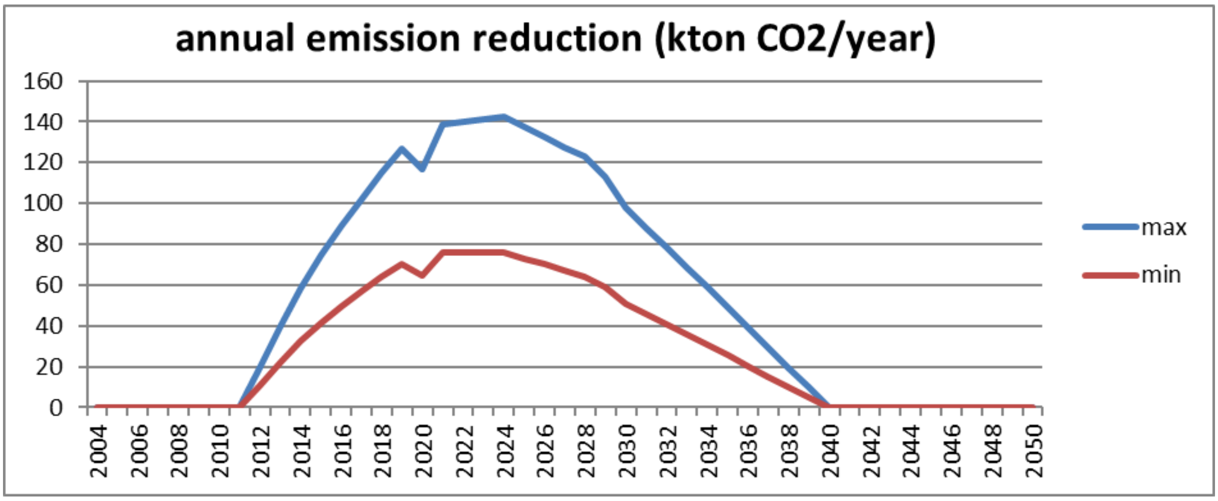


Figure 31: Annual emission reductions of the adapted advantage in kind for salary cars in ktons CO_2/year

3.26.5. Discussion

There have not been major updates of the 2017 estimates. The reasons are:

For the estimates until 2020:

- the major assumption is on the reduction in per km CO_2 emission at the time of the introduction in 2012. There is no better evidence available today than in 2016-2017. So, we keep that estimate.
- the km driven could have been adapted. Although, as this requires extra calculation work for a minor gain that would remain in the error margin of this crude estimate, this was not done.
- We have only introduced a correction for the COVID impact in 2020. Based on the Sciensano epidemiological update of 2-12-2020, we assume a reduction in vkm of 15%, 20%-).

For the future estimates 2020-2040:

The 2017 estimate foresaw in 2025, a reduction of 140 ktons in the optimistic scenario, while it is only half in the minimum scenario. From 2025 on, the impact could be strongly reduced if the company car policy is profoundly changed as the government agreement foresees. With a change in the company car policy, there would be no longer an effect of this measure for new company cars, the effect would fade away with the company cars leaving the car stock progressively. In that case, the provided estimate is an overestimation.

If no drastic change in the company car policy, this estimate is an underestimation.

We remind the reader that it is very difficult to allocate precisely the reductions to one of the different measures that have been taken to make salary and company cars cleaner.

The fact that company cars drive on average more km than other cars is not taken into account here. In that sense this estimation is an underestimation of reality, or on overestimation of the obtained reductions. It is also important to know that the number of company cars continues to growth steadily. While in 2012, around 375 000 company cars were registered, in 2020 around 525 000 company cars are registered. It is therefore very probable that the emission gains obtained from the “benefit in kind” PAM are more than compensated by extra emissions from the increasing number of company cars (driving more km than an ordinary car).

We remark also that the higher the number of km driven is, the higher will be the reduction as the reduction is proportional to the km driven. On the other hand, lower km driven, for example due to COVID-19, means lower emission reductions in 2020.

Remark that it could be interesting to estimate the impact on the lower deductibility of the fuel card (see paragraph 3.26.1 above).

3.26.6. Data Sources

- Emissions and km driven to calculate average Federal planning bureau http://www.plan.be/databases/data-14-fr-base+de+donnees+transport
- ICCT. From laboratory to road. 2015 and 2018
- http://www.jobat.be/nl/artikels/de-20-populairste-bedrijfswagens-van-2015/
- SBB. kost van een bedrijfswagen. 2019
- Sciensano. Epidemiologische update. 2-12-2020. https://covid-19.sciensano.be/sites/default/files/Covid19/20201202_RAG_Update%20epidemiologie_NL.pdf
- SPF Finances. Nouvelles règles de calcul et FAQ. Avantage de toute nature résultant de l’utilisation à des fins personnelles d’un véhicule mis gratuitement à disposition par l’employeur/entreprise.

3.27. XX-X01: Ecocheque

3.27.1. Description

The eco-cheque is a new extra-legal advantage that the employer can provide to workers, in the similar way as the gift cheque. This eco-cheque is dedicated to ecological products or services. Its application area is very wide, from the "economy light bulb" to "ecological cleaning products".

As for the gift cheque, the eco-cheque is exempt from taxes and social contributions.

The eco-cheque mechanism has been fully defined in the CCT (Convention Collective du Travail) n°98 of the “Conseil National du Travail”.

This PAM results in a reduction of emissions in both ETS and non-ETS sectors.

3.27.2. Methodology

In the absence of additional information, the current estimation is based on expected emission reductions estimated by CO_2logic by type of appliance, following the same general methodology described in the previous assessment (VITO/Econotec 2015).

The annual emission reduction is calculated as *follows*:

$$ER_t = \sum_i N_{t.i} \cdot ER_i \cdot A_i$$

With

$\mathbf{ER_t}$: Annual emission reduction
$\mathbf{N_{t.i}}$: cummulative number of efficient appliances of type i
$\mathbf{ER_i}$: Unit CO2 reduction per appliance of type i (efficient appliance respect to the usual one)
$\mathbf{A_i}$: Allocation factor to federal measure per appliance of type i

As the estimation is based on the study of CO_2logic. it has not been possible to estimate different minimum and maximum scenarios, being the effect of the PAM and its corresponding uncertainties those estimated by CO_2logic.

3.27.3. Main assumptions

A. General assumptions

- Annual reductions in CO_2 emissions are estimated based on a constant level of substitution per type of appliance (new units in operation).
- For economy light bulb. it is assumed that there is no effect after 2013 because it becomes the standard.
- For television, the expected effect will be reduced throughout the period as the offer and the price reduction will naturally lead the purchase choice to the LED technology.
- For freezers, the standard for freezer becomes A+ and will soon become A++.
- The use of the bicycle has been assumed to be used once a week for a short travel (7.5 km).

3.27.4. Data sources

The data sources used for the estimation of the PAM are presented in the following table:

Indicators	Source
Unit CO_2 reduction per appliance of type i (efficient appliance respect to the usual one)	CO_2logic, 2010

Table 60: Description of data sources

3.27.5. Results

The emission reductions achieved by the implementation of the PAM increase from 20 kt CO_2-eq in 2009 to 373 kt CO_2-eq in 2035 and 571 kt CO_2-eq in 2050. The following figure illustrate the emission reductions achieved from 2004 to 2050 by the PAM:

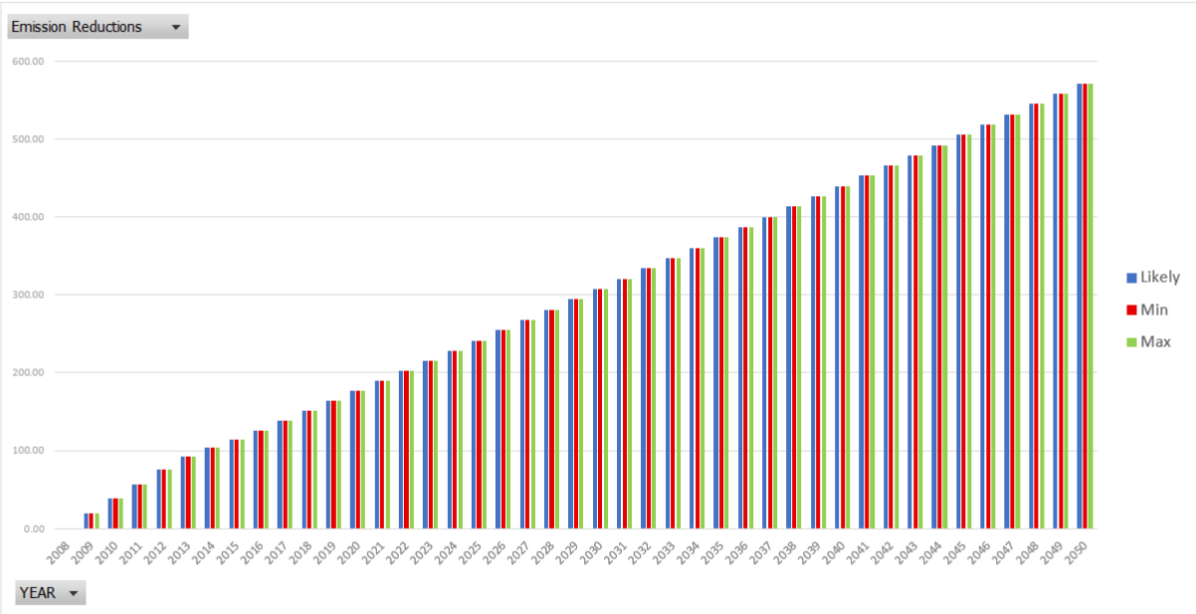


Figure 32: Annual emission reductions (minimum, maximum and likely scenarios)

3.27.6. Discussion

Information on the use of the eco-cheques could enable an update on the methodology, that now strictly depends on the study made by CO_2logic.

3.27.7. Update of the PAM

The initial consultations and data gathering conducted in January and February 2021 with federal public services in Belgium for the 2021 update of the PAM presented raw data from stakeholders that did not lead to new information relevant to the action. Data was provided by Fre Maes and Bram Soenen from FPS Health which was analysed, but this information was not sufficiently specific for the update.

Further consultations were conducted in March 2021 with Bram Verckens from FPS Economy, the National Work Council, and the Voucher Issuers Organization. Bram Verckens analyzed the data requirements for the update but could not provide the necessary data. The National Work Council mentioned that they cannot provide the requested figures and technical data such as the number of efficient appliances per type and the CO_2 reduction per appliance type and have not been involved in the 2010 CO_2logic report or the more recent report from the Voucher Issuers Organization. The Vouchers Issuers Organization conducted this more recent research into the climate impact of eco-cheques in Belgium in 2019. However, only the executive summary was accessible and not the full report, which might have entailed useful information for the update of the PAM. The data gathering developed in early 2021 did thus not lead to new relevant information related to the action and the PAM could not be updated.

3.27.8. References

- CO_2logic, 2010. Analyse des avantages CO_2 des produits éco-chèques. Sodexo.

3.27.9. XX-X02: Green loans

3.27.10. Description

The measure consists in a subsidy of the federal government reducing by 1.5% the interest rate of bank loans for energy saving investments of households that are mentioned in a list including thermal insulation, double glazing, condensing boilers, heat pumps and solar panels. It is part of the economic law of 27 March 2009. It is a temporary measure, only applicable to loans awarded between 1st January 2009 and 31st December 2011. Although the green loans for energy saving investments of households ended by 31 December 2011, and that from 1 January 2012 it is no longer possible to benefit from the system with new loans, old loans continue to benefit from the tax advantage.

3.27.11. Methodology

This PAM completely overlaps with measure EC-B01, because green loans can be combined with a tax reduction. Therefore, the impact of this measure cannot be added to the total emission re*ductions by all federal PAMs.*

The annual emission reduction is calculated as *follows*:

$$ER_t = \sum_i N_t \cdot P_i \cdot ER_i \cdot A_i$$

With

$\mathbf{ER_t}$ = Annual emission reduction
$\mathbf{N_t}$ = cummulative number of green loans
$\boldsymbol{P_i}$ = Distribution between investments or technologies
$\mathbf{ER_i}$ = Unit CO2 per investment
$\mathbf{A_i}$ = Allocation factor to federal measure per investment

FPS Economy provided information on the number of green loans for the period 2009-2018. The period from 2012 is considered the phasing-out period, as it is no longer possible to benefit from the system with new loans from 1 January 2012. However, old loans continue to benefit from the tax advantage and have gradually been decreasing since 2012.

To allocate the number of loans to the different technologies, the distribution observed in measure EC-B03 (FRGE, all applications) was used. This is a different distribution than for measure EC-B01, which reflects the fact that costly investments (e.g. PV panels) are more likely to occur proportionally for a loan.

The unit emission reductions of measure EC-B01 are used also in this PAM.

Finally, part of the emission reduction was allocated to the regional level (corresponding to financial support provided by grants and green certificates). To estimate the financial contribution of the Federal government, we calculated the benefit of a 1.5% reduction of the interest rate on a loan (mean cost for different technologies based on information of FRGE) for a period of 5 years.

3.27.12. Main assumptions

A. General assumptions

- Unit emission reductions and federal allocation factors per technology match with the factors applied in the PAM EC-B01 (Financial incentives for rational use of energy).
- Number of applications receiving loans in the phase-out period post the years from the raw data provided by FPS Economy (after 2018) will follow a constant percentage accumulative decrease of 16.03%, which is consistent with the decrease-rate of the last year from the raw data between 2017 and 2018.
- For the financial contribution of the Federal government, the benefit of a 1.5% reduction of the interest rate on a loan was estimated (mean cost for different technologies based on information of FRGE) for a period of 5 years.
- To allocate the number of loans to the different technologies, the distribution observed in measure EC-B03 (FRGE, all applications) was used.
- Once the investments are made, the emission reductions attributable to the investments are accounted until the end of the life expectancies of the technologies which have been funded with the investments. The life expectancies of the different technologies are extracted from the National Energy Efficiency Action Plan.

3.27.13. Data sources

The data sources used for the estimation of the PAM are presented in the following table:

Indicators	Source
Number of green loans	Personal communication of FPS - FPS Economy
Life expectancies	National Energy Efficiency Action Plans
ERi	PAM EC-B01

Table 61: Description of data sources

3.27.14. Results

The emission reductions achieved by the implementation of the PAM increase from 16 kt CO_2-eq in 2009 to 1 379 kt CO_2-eq in 2022 (national total emissions). From 2022 to 2030, the emission reductions achieved are relatively constant, before starting to decrease from 1.240 kt CO_2-eq in 2031 to 7 kt CO_2-eq in 2050. The temporal evolution of the emission reductions is driven by the life expectancies of the technologies that have been funded with the investments, as the emission reductions are accounted until the end of the lifetime of the technologies.

The following figure illustrate the emission reductions achieved from 2004 to 2050 by the PAM.

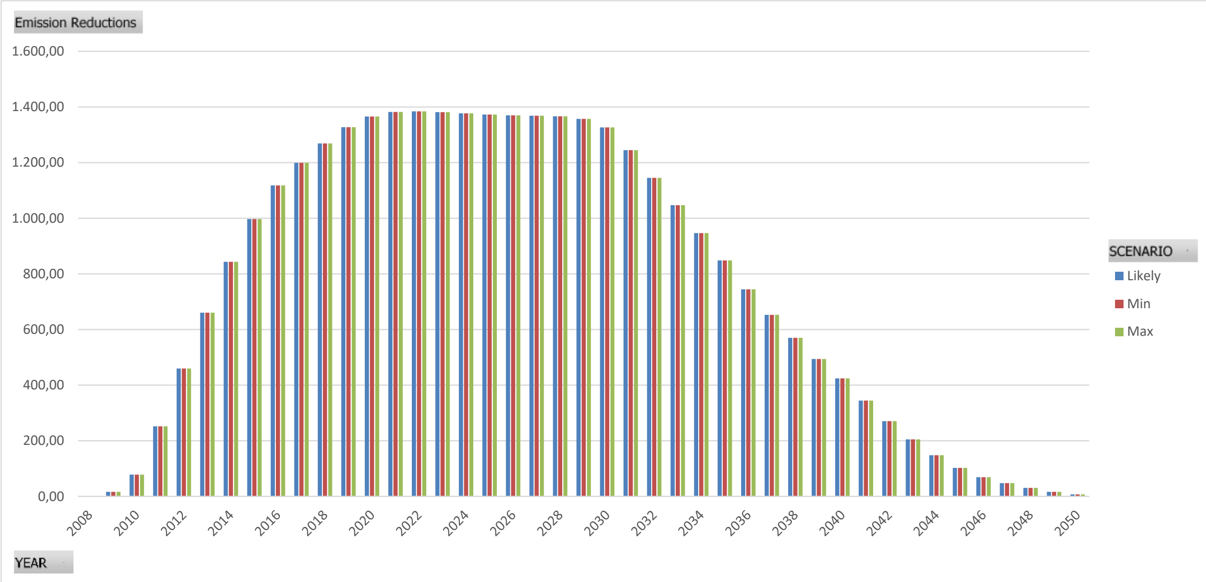


Figure 33: Annual emission reductions (minimum, maximum and likely scenarios)

3.27.15. Discussion

From 2012, the emission reductions are still above zero because there are technologies still in use. As mentioned before, this concerns the life expectancies of the technologies that have been funded with the investments, as the emission reductions are accounted until the end of the lifetime of the technologies, i.e., their lifetime goes beyond the 2012 ending of the policy. This has been considered a constant rate following the change from the latest data years, however, there could be abrupt larger changes in the number of technologies still in use.

3.27.16. Update of the PAM

The initial consultations and data gathering conducted in January and February 2021 for the update of the PAM provided revised data from Jean-Baptiste Traversa from the Tax Policy Unit within FPS Finance concerning the number of new green loans for the period 2009-2018. It was reiterated during this consultation process that the period from 2012 is considered the phasing-out period, as it is no longer possible to benefit from the system with new loans from 1 January 2012. However, old loans continue to benefit from the tax advantage and have gradually been decreasing since 2012. This revised data was incorporated into the PAM and no further consultations were required with FPS Finance concerning this PAM.

Additional updates on the unit emission reductions and federal allocation factors per technology will depend on the update of PAM EC-B01 and the update on the allocation of the number of loans to the different technologies will depend on the update of PAM EC-B03. The information used from these two other PAMS was cross-checked to ensure consistency.

3.27.17. References

- European Commission, 2017. National Energy Efficiency Action Plans and Annual Reports. Available at: https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficiency-directive/national-energy-efficiency-action-plans

3.28. XX-X03: EU Regulation of F-gases

3.28.1. Description

The use of fluorinated gases (F-gases) is widespread in industrial and commercial applications. F-gases are greenhouse gases which have a very high global warming effect. To control emissions of F-gases, the EU adopted in 2006 the F-gas Regulation (842/2006), intended to control the production and the consumption of F-gases and incentivize the use of alternatives with less impact on climate change. In 2014. the original F-gases Regulation was replaced by Regulation 517/2014, which strengthen the existent measures and introduced new provisions on F-gases consumption and production, applicable from 2015. The main provisions of the new F-gases Regulation are the following:

- Limitation of the total amount of gases that can be sold in the EU, with the target of reaching an amount of one-fifth of 2014 sales.
- Banning the use of F-gases in certain application where less harmful alternatives are available in the market.
- Preventing the emissions from existent equipment by enhanced maintenance, quality control checks and recovery of gases.

The F-gases regulation impacts on the future evolution of GHG emissions in the following IPCC categories:

- Commercial refrigeration
- Industrial refrigeration
- Stationary refrigeration
- Domestic refrigeration
- Transport refrigeration
- Foam blowing agents – closed cells
- Fire protection
- Technical aerosols

This PAM results in a reduction of emissions in the non-ETS sector.

3.28.2. Methodology

The assessment of impact of this PAM is based on the study "Projections of fluorinated greenhouse gas emissions in Belgium for the years 2020-2040"[20] developed in 2019. This study estimated the F-gases emissions of Belgium up to year 2040 considering the impact of Regulation 517/2014. The estimate carried out in this study is fully consistent with the national GHG emission inventory submitted by Belgium to the UNFCCC (time series 1990-2017), and covers all the gases, emission sources and provisions of the F-gas Regulation.

F-gases projections are developed in a With Existing Measures (WeM) scenario. This means that the historical F-gas emissions of Belgium are projected in one scenario which considers the impact of the regulation, providing the emission levels of the country after the implementation of the Regulation.

This PAM assessment builds from the WeM scenario developed in projections for estimating the impact in terms of GHG emissions reduced of the Regulation 517/2014. The estimation of impact is carried out by estimating a Without Measures Scenario (WoM), which represent the F-gas emissions of the country in a scenario in which the Regulation is not implemented.

[20] VITO & ECONOTEC, 2019. Projection of fluorinated greenhouse gas emissions in Belgium for the years 2020-2040. development of the WEM-scenario. Study commissioned by the Federal Public Service of Public Health, Food Chain Safety and Environment, on behalf of the National Climate Commission

$$Federal\ Emission\ reduction_t = [WoM\ emissions_t - WeM\ Emissions_t] \cdot Federal\ Allocation\ Factor_t$$

The WoM scenario has been estimated at sub-category level, considering that the evolution of emissions follows the same trend of the historical time series before 2010 (i.e. the emissions of F-gases from 2010 are already affected by the expectations of the updated F-gases regulation). The calculation was made using linear regressions at sub-category level, considering the time series 1995-2009, with the following exceptions:

- When a structural break is identified in the times series, the reference time series have been narrowed.
- In the cases where the linear regression could not be used due to the statistical characteristics of the time series, the value of 2009 has been subrogated for the projected period.

A federal allocation factor was estimated considering the following provisions of the F-gas Regulation:

- Provision 1: Limitation of the total amount of gases that can be sold in the EU, with the target of reaching an amount of one-fifth of 2014 sales, Annex V if the F-gas Regulation.
- Provision 2: Banning the use of F-gases in certain application where less harmful alternatives are available in the market, Annex III of the F-gas Regulation.
- Provision 3: Preventing the emissions from existent equipment by enhanced maintenance, quality control checks and recovery of gases, F-gas Regulation except for Annex III and Annex V.

The rationale for attributing each of the provisions to the federal or regional level was provided by the FPS, in personal communication, as follows:

The administration responsible for the implementation of provision 1 is the EU Commission (they hold the registry and issue the quotas. The federal controls the POM (Placing on the market) through custom controls and should react to reports or alerts from the Cion. Provision 1 can therefore be attributed to federal authority.

The administration responsible for the implementation of provision 2 is mainly the federal level. Provision 2 can be attributed to the federal authority.

The administration responsible for the implementation of provision 3 is mainly the regional level. The main interaction with the federal level could occur from the prohibition of selling gas to technicians or companies not holding the appropriate certification. This provision can be attributed to regional authority.

3.28.3. Main assumptions

A. General assumptions

- In the absence of the F-gas Regulation 517/2014, the emissions of F-gases would have followed the trend of the F-gases emissions for years 1995-2009.
- The provisions of the regulation which are attributable to the regions are those related to enhanced maintenance, quality control checks and recovery of gases. This is mainly related to disposal emissions, so the regional allocation of emission reductions is equivalent to the disposal emissions of year 2015, a 17% of total F-gas emissions.

3.28.4. Data sources

The main data sources used for the estimation of the PAM are presented in the following table:

Indicators	Sources
F-gases projections up to 2040	VITO & ECONOTEC, 2019. Projection of fluorinated greenhouse gas emissions in Belgium for the years 2020-2040, development of the WEM-scenario. Study commissioned by the Federal Public Service of Public Health, Food Chain Safety and Environment, on behalf of the National Climate Commission

Table 62: Description of data sources

3.28.5. Results

The total federal emissions and the result of the estimation of the PAM is illustrated in the following table.

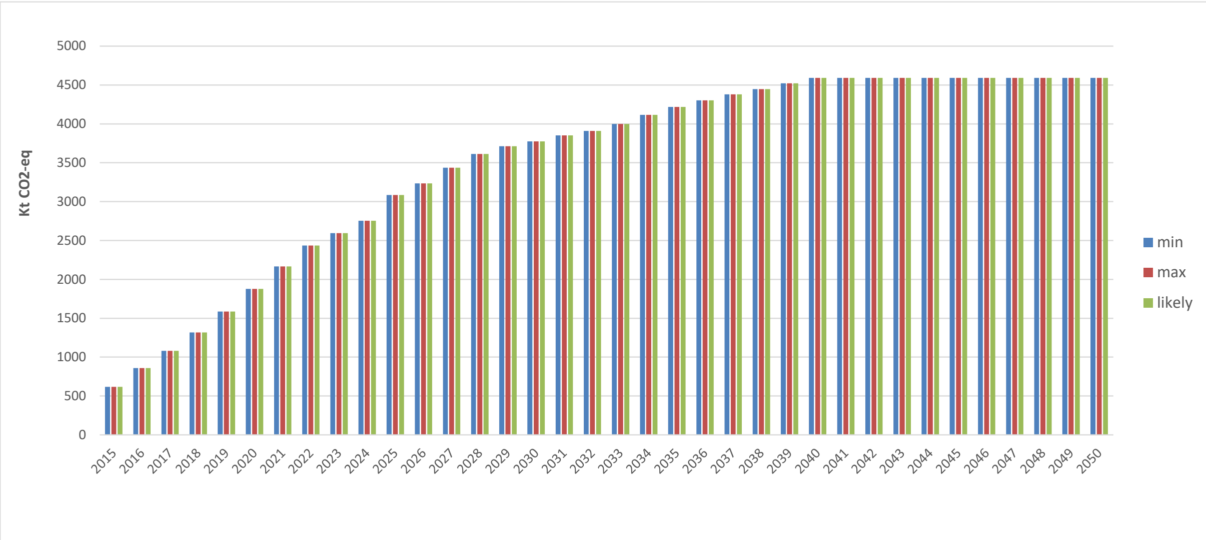


Figure 34: Annual emission reductions (minimum, maximum and likely scenarios)

3.29. XX-X04: Increase of excise duty on diesel

3.29.1. Description

The PAM is motivated by the implementation of the "Royal Decree of 26 October 2015". Published on the 30th October 2015" and law of 27 June 2016. Through this law, the special excise duty for diesel for non-commercial use is increased from 2015 to 2018. The law also establishes the aim of achieving an equality of excises for diesel and gasoline. This modification of taxes influences final automotive fuel consumption (in terms of amount of fuel consumed by car type) that is estimated by this PAM.

In the 2021 update of this PAM, Jean-Baptiste Traversa (MINFIN) confirmed that the rate of excise duty for petrol and diesel will be equal. Since then, until now, the excise duties have not changed. For now, the 2020 update has included new population and brent prices.

This PAM results in a reduction of emissions in the non-ETS sector.

3.29.2. Methodology

A general model has been developed for building two scenarios: the **BaU scenario**, which does not include the effect of the PAM; and a **WeM scenario**, which includes the effect of the PAM.

The modification of the tax affects primarily the price, and indirectly the amount of fuel consumed in passenger cars (PC) by means of the composition of the PC fleet and the fleet mobility. These three variables, **stock, fleet mobility** and **fuel consumption for passenger cars**, are the three key factors that have been considered for estimating the impact in terms of GHG emissions of this PAM as the difference between both scenarios.

$$GHG = \sum_f FC_f \, EF_f$$

$$\mathrm{FC}_f = \sum_f KM_f \sum_{s.e.a} VEH_{f.s.e.a} \;\; CF_{f.s.e.a}$$

With

$GHG = GHG\ emissions\ for\ passenger\ cars$ (PC)

$\mathrm{EF}f$ = GHG emission factor $for\ PC\ propelled\ by\ fuel\ type\ f$

FCf= Energy consumption from fuel f

$\mathrm{KM}f = distance\ travelled\ by\ PC\ propelled\ by\ fuel\ type\ f$

$\mathrm{VEH}_{f.s.e.a} = stock\ of\ PC\ of\ size\ s\ and\ age\ class\ a\ with\ engine\ type\ e\ propelled\ by\ fuel\ type\ f$

$\mathrm{CF}_{f.s.e.a} =$ Consumption factor per $km\ for\ PC\ of\ size\ s\ and\ age\ class\ a\ with\ engine\ type\ e\ propelled\ by\ fuel\ type\ f$

The methodology starts from the estimation of the **projected stock** by fuel type, vehicle size, technology type (conventional vs. hybrid) and vehicle age for years 2015-2030. This procedure has been implemented on the time series of fleet for the period 2006-2014 provided by TML (see section 2.3 below).

The method used for estimating the fleet is composed by six steps, as follows:

1. Projection of the **total stock**. The total number of vehicles (annual stock) has been projected by adjusting a linear regression with population as follows:

$$VEH_t = \propto + \beta Pob_t$$

With

$$VEH_t = Stock.year\ t$$
$$Pob_t = Population.year\ t$$

2. Projection of the **deregistration of vehicles**. Historical deregistration rate for each fuel type, vehicle size and age has been derived for conventional engine vehicles from the detailed information available on the historical stock. The fleet scrapped in year t has been calculated by applying directly these rates on the stock existing in year t-1:

$$DV_{f.s.e.a.t} = \overline{DVR^H_{f.s.a}}\ VEH_{f.s.e.a-1.t-1}$$

With

$$DV_{f.s.a.t} = Fleet\ scrapped.size\ s.engine\ e.age\ a.year\ t$$
$$\overline{DVR^H_{f.s.a}} = Mean\ historical\ deregistration\ rate.size\ s.engine\ e.age\ a$$
$$VEH_{f.s.a-1.t-1} = Stock.size\ s.engine\ e.age\ a-1.year\ t-1$$

3. Projection of the **series of total new vehicles**. Annual new fleet is directly projected from the total passenger car stock (step 1) and the overall deregistered vehicles (step 2) projected for the reference year.

$$NV_t = VEH_t - DV_t$$

With

$$NV_t = New\ vehicles.year\ t$$
$$VEH_t = Stock.year\ t$$
$$DV_t = Deregistration\ of\ vehicles.year\ t$$

4. Characterization of **new fleet per fuel type**. Time series of new vehicles per fuel type have been projected based on the historical elasticities of the percentages of each fuel in the overall stock with respect to the rate of fuel prices (gasoline price vs diesel price):

$$\frac{\Delta \frac{NV_{f.t}}{NV_t}}{\frac{NV_{f.t}}{NV_t}} = \alpha_f \frac{\Delta \frac{Gasoline\ price}{Diesel\ price}}{\frac{Gasoline\ price}{Diesel\ price}}$$

5. Characterization of **new fleet per fuel type and car size**. New fleet composition projected in step 4 has additionally been subdivided by car size by applying the projected size composition for each fuel type. Rate for each fuel type and vehicle size has been projected according to its observed temporal evolution.
6. Characterization of **new fleet per fuel type. car size and engine type** (conventional vs hybrid). Distinction between conventional and hybrid engines has been achieved by estimating the **penetration projected of the hybrids**. Projection of the participation rates of conventional

vehicles in the new fleet per fuel type and car size has been carried out by analysing the historical penetration and adjusting the series to sigmoidal functions for the projected years[21].

Following the implementation of these 6 steps, the historical detailed data on stock (by fuel type, vehicle size, engine type and vehicle age) have been projected until 2030 for gasoline and diesel passenger cars.

Once the stock is calculated, the second step in the methodology is the estimation of the **fleet mobility**. With this purpose, the Statbel[22] historical data on annual kilometers travelled per vehicle has been used and projected. The projection of these series is different in the BaU and WeM scenarios and is therefore described below in section on specific methodology according to the scenario.

To project the fuel consumption, series of **annual consumption factors** have been estimated by applying Tier 2 consumption factors from EMEP/EEA & COPERT 4[23]. These consumption factors are referred to the distance travelled, and they are differentiated by size, fuel, EURO technology and engine type. The collection of factors gathered from this guideline has been completed for all the vehicle types (combination of fuel type, size, age class, engine) and, in so doing, the factors for hybrid engines has been calculated by scaling the respective ones for conventional engines with a fuel consumption efficiency rated derived from the comparison of factors for a EURO medium size (1.4-2.0 l) gasoline passenger cars propelled by the both engine types.

It has been assumed that the original consumption factors, expressed in terms of g/km, are referred to fossil fuel consumption, i.e. without any biogenic content. We have assumed that the energy requirement should be kept for vehicles that consume fuel with a non-zero biogenic fraction and, therefore it has been calculated annual consumption factors in terms of energy units as follows:

$$CF_{f.s.e.a.t}[\frac{GJ}{km}] = \left. CF_{f.s.e.tech}^{EMEP}\,[\frac{g\ fossil}{km}]\ NCV_f[\frac{GJ}{t}] \middle/ FF_{f.t}[\%\ energy] \right.$$

With

$$CF_{f.s.e.a.t} = \ Consumption\ factor.fuel\ f.size\ s.engine\ type\ e.year\ t$$

$$CF_{f.s.e.tech}^{EMEP} = \ EMEP - EEA\ consumption\ factor.fuel\ f.size\ s.engine\ type\ e. \ EURO\ technology\ tech\ associated\ to\ age\ a$$

$$NCV_f = \ Net\ calorif\ value\ (only\ fossil\ part).fuel\ f$$

$$FF_{f.t} = \ Fossil\ fraction.fuel\ f.year$$

Time series projected on stock composition resulting from the previous steps has been used to calculate the annual consumption factors for each fuel. These annual consumption factors multiplied by the distances travelled have led to the final fuel consumption series.

These estimate of consumption per fuel type projections have been multiplied by GHG emission factors for obtaining **GHG emissions**. These emission factors are the implied emissions factors by fuel type extracted from the National Emissions Inventory). These reported factors have been adjusted to consider the biogenic content in the automotive fuels. So, the CO_2 emission factors have been corrected by the evolution of the fuels projected in the BFP study “Perspectives de l’évolution de la demande de transport en Belgique à l’horizon 2030. Décembre 2015”.

[21] The sigmoidal functions estimate non-negative values and show a good adjustment to the expected evolution (progressive decrease, with no backward evolution). The sigmoid functions analyzed for this assessment have been the logistic, Weibull and Gompertz function. Assuming a high hybrid penetration rate according to the BFP studies on Belgian transport forecast, it has been adopting for each year, fuel type and vehicle size the minimum annual rate among the results from three abovementioned sigmoid functions.

[22] Belgian Federal Government - Directorate-general Statistics

[23] http://www.eea.europa.eu/themes/air/emep-eea-air-pollutant-emission-inventory-guidebook/emep.

$$EF_{CO2.f}\left[\frac{kg}{GJ}\right] = EF_f^{CRF}\left[\frac{kg}{GJ\ fossil}\right] FF_{f.t}[\%\ energy]$$

For non-CO_2 GHG, emission factors by fuel type have been estimated by weighting the emissions factors for the fossil part and the emission factor for biomass reported in CRF according to its biogenic content in the last historical year available (year 2014). This biogenic content type has been derived for each fuel from the data of fossil automotive fuel consumption reported in CRF and the biofuel (renewable fraction) consumption published in EUROSTAT energy balance for Belgium.

The resulting emission factors are shown in the following table.

	CO_2 (t/TJ)		CH_4 (kg/TJ)		N_2O(kg/TJ)	
	GASOLINE	DIESEL	GASOLINE	DIESEL	GASOLINE	DIESEL
2015	68.17	69.62	6.62	0.31	0.67	2.65
2016	67.54	69.23	6.62	0.31	0.67	2.65
2017	66.91	68.83	6.62	0.31	0.67	2.65
2018	66.28	68.43	6.62	0.31	0.67	2.65
2019	65.64	68.03	6.62	0.31	0.67	2.65
2020	65.01	67.64	6.62	0.31	0.67	2.65
2021	64.98	67.60	6.62	0.31	0.67	2.65
2022	64.95	67.57	6.62	0.31	0.67	2.65
2023	64.91	67.54	6.62	0.31	0.67	2.65
2024	64.88	67.50	6.62	0.31	0.67	2.65
2025	64.85	67.47	6.62	0.31	0.67	2.65
2026	64.82	67.44	6.62	0.31	0.67	2.65
2027	64.78	67.40	6.62	0.31	0.67	2.65
2028	64.75	67.37	6.62	0.31	0.67	2.65
2029	64.72	67.34	6.62	0.31	0.67	2.65
2030	64.69	67.30	6.62	0.31	0.67	2.65

Table 63: GHG emission factors

It is also worth highlighting the estimation of the **fuel price series** and its role in the methodology.

Time series of fuel prices (with taxes) are used for the projection of the composition of the fleet (see projection of the series of new vehicles per fuel type above) and also for the estimation of kilometres travelled by type of car. The different price series used in the BaU and WeM scenarios ultimately led to fuel consumption differences and therefore differences in the GHG emissions projected in each scenario.

The methodology above described has been used for estimating both scenarios. The only difference between scenarios is the way in which **kilometers traveled** are calculated, as follows:

BAU scenario

In this scenario, the kilometers travelled depends on the diesel price as described in the following equation:

$$\frac{\Delta\ km}{km} = \beta \frac{\Delta\ Diesel\ price}{Diesel\ price}$$

The high correlation in the historical period between diesel and gasoline prices series indicate that kilometers traveled of cars using both fuels can be estimated using only one variable. in this case diesel price.

WeM scenario

In this scenario, the kilometers traveled are calculated independently for gasoline and diesel cars, with the objective of reflecting the impact of the tax in the **fuel price** and **fuel consumption** which will be translated in a different amount of kilometers traveled in diesel and in gasoline cars. For gasoline cars, kilometers traveled are calculated by applying the WeM/BaU price elasticity to the kilometers traveled calculated in the BaU scenario, as follows:

$$\frac{\Delta\, km^{G}{}_{s}}{km^{G}{}_{s}} = \gamma_s \frac{\Delta\, Gasoline\ price}{Gasoline\ price} . s\ scenario$$

$$km_{Gasoline.t.WeM} = km_{Gasoline.t.BaU} \cdot \left(\frac{km^{G}{}_{t.WeM}}{km^{G}{}_{t.BAU}}\right)$$

With

$$km^{G}{}_{s} = \ kilometers\ travelled\ per\ vehicle. gasoline\ cars. scenario\ s\ \big(s \in \{BAU.WeM\}\big)$$
$$projected\ on\ the\ gasoline\ price\ (elasticity)$$

$$km_{\boldsymbol{Gasoline}.t.\boldsymbol{BAU}} = kilometers\ travelled\ per\ vehicle. gasoline\ cars. year\ t. BAU\ scenario$$

$$km_{Gasoline.t.WeM} = kilometers\ travelled\ per\ vehicle. gasoline\ cars. year\ t. WeM\ scenario$$

3.29.3. Main assumptions

A. General assumptions

- Projected period: From 2031 onwards, it has been assumed the reduction effect projected for 2030.
- Scenarios Likely, Min (minimum reduction) and Max (maximum reduction): For the assessment of this PAM one reduction scenario have been projected. It has been opted to equalize the reductions associated to the three reduction scenarios in the following section of results.
- Vehicle types: The PAM has been evaluated as the effect on the mobility and consumption of the passenger cars. The contributions of other vehicle types directly affected by the law (motorcycles or mopeds) or indirectly (via a modal change) on the overall impact are considered to be negligible.
- Alternative energy carriers: This assessment contemplates the effect on the vehicles propelled by gasoline or diesel, either by conventional engines or by hybrids (fuel and electricity) ones. PAM´s impact on the electricity consumption by hybrid vehicles is considered to be negligible.
- Subjects affected by the PAM (fuel prices): Components in the emissions resulting that have been estimated to be directly affected by the fuel prices are: i. share of the gasoline (conventional or hybrid engine) vehicles in the overall passenger car fleet and ii. annual distance travelled per vehicle.
- Deregistration rate: Constant rates per fuel engine, size and vehicle age have been applied for all the years projected.
- Biogenic content in the automotive fuels: Projected linear increase taking estimates from BFP study (for 2020 and 2030) as reference years.
- Non-CO_2 emission factors: Constant factors per fuel type have been applied for all the years projected. These factors have been calculated based on the implicit emissions factors reported

by the Belgium Emission Inventory, by weighting by the consumption estimates the emission factor for the respective fossil fraction and the one for biomass (that includes all biofuel types).

B. BAU scenario assumptions

- From 2020 onwards, the interannual change has been assumed zero (i.e. same tax from 2020)

C. PAM scenario assumptions

- The PAM scenario is reflected in the fuel prices for years 2015-2018.

3.29.4. Data sources

The main data sources used for the estimation of the PAM are presented in the following table:

Indicators	Sources
Population	http://statbel.fgov.be/fr/modules/publications/statistiques/population/downloads/population_au_1er_janvier_2017-2061.jsp
GHG emission factors (EF)	Belgian 2016 submission to the UNFCCC
Crude brent	US Energy Information Administration
	World Bank Commodities Price Forecast (Crude oil. avg. spot)
Inflation rates – forecast	Banque Nationale Bank de Belgique
Index rates – historical	Belgian Petroleum Federation
	Official document with excise rates for energy products
Prices wo.taxes -historical	Weekly Oil Bulletin by Energy Statistics of the European Commission
Vehicle stock (VEH) - historical	Based on the historical data on vehicle fleet provided by TML
New vehicles (NV)– historical	Based on the historical data on vehicle fleet provided by TML
Deregistration rate (DV) – historical	Based on the historical data on vehicle fleet provided by TML
Distance travelled (km) – historical	Statistics Belgium (Statbel)
Consumption factor (CF)	EMEP/EEA, 2016
Biogenic content - forecast	BFP, 2012

Table 64: Description of data sources

3.29.5. Results

The total federal emissions and the result of the estimation of the PAM is illustrated in the following table.

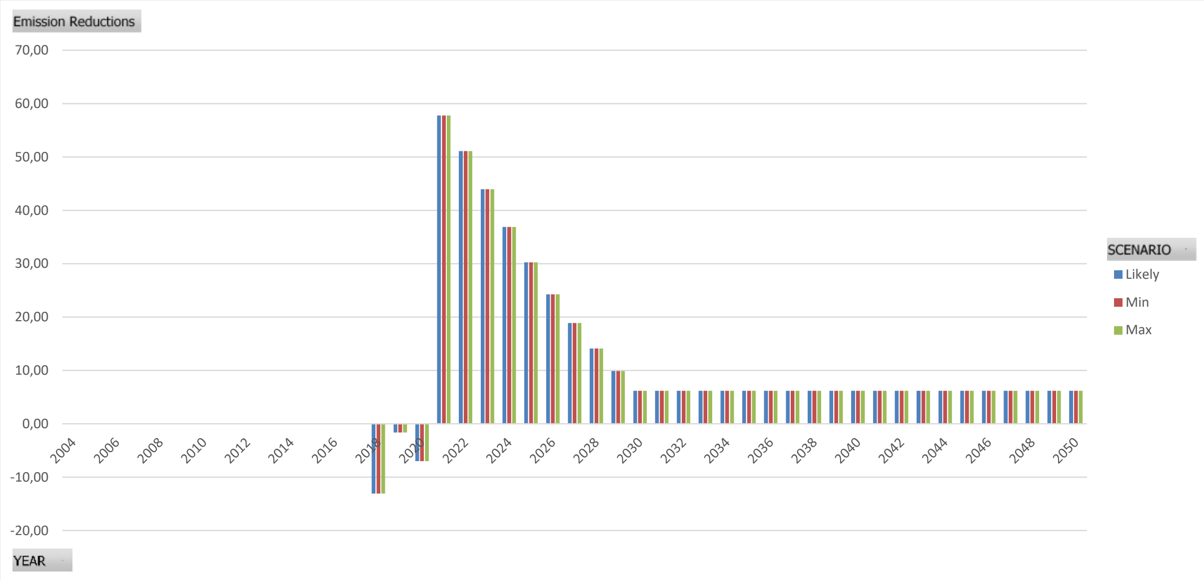


Figure 35: Annual emission reductions (minimum, maximum and likely scenarios)

3.29.6. References

- EMEP/EEA 2016. 2016 EMEP/EEA air pollutant emission inventory guidebook 2016 - Update Dec. 2016.
- BFP, 2012. Perspectives de l'évolution de la demande de transport en Belgique à l'horizon 2030. Septembre 2012. Version corrigée en décembre 2012. Published by: Bureau fédéral du Plan and Service public federal Mobilité et Transports.

4. Socio-economic impacts evaluations

4.1. General framework

There is no consensus on socio-economic evaluation of PAMS. Several different methods are used both in research and in practical national evaluation experiences. Although pros and cons of each method of evaluation are perfectly clear and acknowledged, no guidelines or best practices emerge clearly from recent experience (ICEDD2016).

Furthermore. even if some concepts were defined to better characterize the scope of analysis (as direct, indirect, net and gross impacts) their use are not transparent and the scope of analysis may differ from one study to another.

To cope with this lack of transparency and clearly define the scope of analysis, we propose in this section to build a simple framework of evaluation based on economic theory.

In this section, we first present the theoretical background necessary to understand the impacts a public policy may have on markets. We then propose a framework of evaluation based upon the main important characteristics highlighted in the economic theory (Section 4.1.2). Then this framework is applied in section D to some federal PAMs.

4.1.1. Market of goods and services: theoretical background

In a competitive market, our economic model may be represented by the equilibrium between supply and demand (Figure 36). This equilibrium will determine the price P of goods, i.e. the point where the quantity demanded equals the quantity supplied (Q). In a theoretical way, there are as many markets as the number of goods and services.

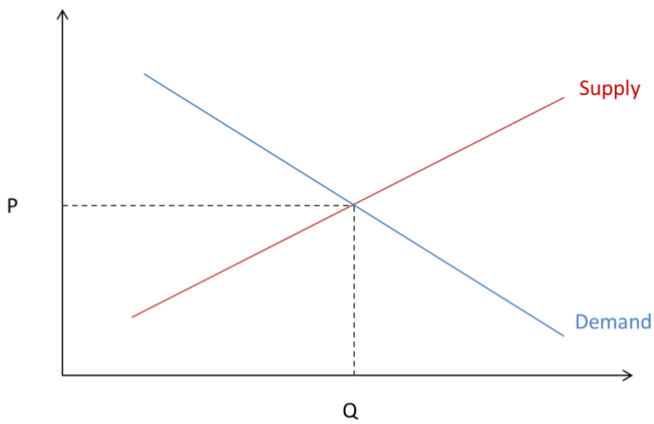


Figure 36 : Equilibrium between supply and demand

The supply corresponds to the quantity of goods and services that a producer wants to sell at a given price. The supply can be represented as an increasing function of the price (Figure 36). In other words, the higher the price, the more the producer is willing to sell. A contrary, if the price is lower, the producer is willing to sell a lower quantity of goods and services.

The demand side corresponds to the quantity of goods and services that the consumers are willing to purchase at a given price. The demand can be represented as a decreasing function of the price (Figure

36). As a consequence, the quantity purchased by the consumers will decrease if the price is higher and increase if the price is lower[24].

Looking at Figure 37, we may easily understand that:

- A modification of the supply or the demand will impact the market equilibrium;
- The slope, i.e. the elasticity, of the supply and the demand will determine the level of impact when there is a modification of the supply or the demand.

These elements may be illustrated by the Figure 37. For instance, if the supply moves towards the left, it will also move the market equilibrium: the quantity of goods and services sold will decrease while the price of theses goods and services will increase.

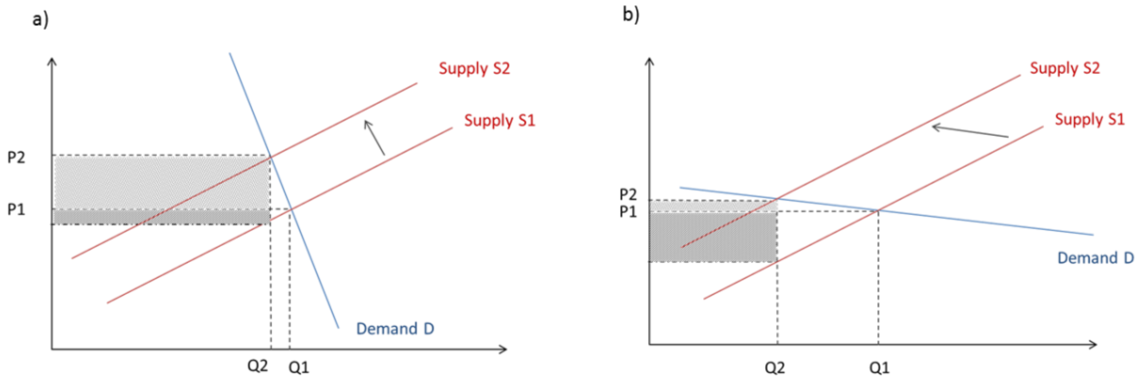


Figure 37 : Incidence of supply shift on producers (dark grey) and consumers (light grey) when the demand is inelastic (a) and when the demand is elastic (b).

Figure 37 also illustrates that the demand and the supply elasticities determine how the producers and the consumers are impacted. When the demand is inelastic, then a modification of the supply will mainly impact the consumers as (light grey, Figure 2a). Indeed, as the consumer demand is quite inelastic, the modification of the price will not greatly impact the quantity purchased: there are willing to pay more to have the goods and services concerned. The contrary is true if the demand is elastic (Figure 2b). Indeed, the quantity purchased will decrease a lot with a slight increase in price. The elasticities of demand and supply depend on the market of good and supplies considered.

The movements in supply and demand may be due to two kinds of elements. First, natural shocks on the market may occur. For instance, regarding the demand side, a mode effect may increase the demand for a given good (translation of the demand curve to the right). A contrary a decrease of revenue for consumer may diminish the quantity demanded (translation of the demand curve to the left, Figure 36). Regarding the supply side, if a firm increase its productivity, it will reduce its production costs and the firm will be able to propose its goods at a lower price (translation of the supply curve to the right). A contrary if the price of a raw material used by a firm increase (as fossil fuel) then the production costs of the firm will increase and the quantity of goods sold for the same price will decrease. In all cases, the market will thus reach a new equilibrium that is function of the elasticities of both curves. According to the liberal economists, this new equilibrium will be reached naturally: the price of goods and services will vary according to the modification of supply and demand.

However, this theory is applicable only if markets follow a model of pure and perfect competition, which is not always the case in practice. For instance, non-competitive markets may occur when there is only one supplier for a lot of consumers (monopoly) or when the goods and services are produced by few global firms (oligopoly). In both cases, the prices will not be defined by the market mechanisms

[24] However, it has to be noted that these figures aren't right for some specific goods and services. For instance, for luxury goods, the quantity purchased may increase if the price increases. We won't speak about these kind of good and services here.

described here above since the firms may define – or at least largely influence – the market price. In the same manner, this theory does not consider potential externalities arising from the market, as pollution.

In those cases, the public authorities play an important role by defining policies to prevent non-competitive behavior or excessive negative externalities. These policies will regulate the market equilibrium by defining – for instance - taxes,subsidies or regulation measures on the production side as well as awareness-raising measures on the consumption side. According to the measure implemented,it will thus primarily imply a move of the supply curve or the demand curve.

As set before, in function of the movement of the curve and the characteristic of the market, the incidence of the policy will be distributed differently on the producer and on the consumer. A main question arising from a policy implementation is thus to identify who will be impacted and at which level. However, the evaluation of a policy impact in practice is not as easy as described here above, i.e. by a modification of quantity sold and price of the goods. Indeed, it is difficult to assess the elasticities of supply and demand and to take into account additional indirect and induced impacts on the supply and demand that may modify the market equilibrium.

Various operational frameworks of policy evaluation have been defined but none of them closely fit to the theory. In this document, we propose a new operational framework, based on the concept developed in previous studies and by linking the impacts considered with the economic theory.

4.1.2. From theory to practice

In practice, the estimation of the impact of a public policy is not as evident as stated by economic theory. Indeed, assessing all impacts on the market arising from a measure is a huge work. Few studies make the whole evaluation of impacts because it would need a myriad of data and the development and use of macroeconomic models: it is often too time consuming and resource intensive.

The problem arising from this is that the scopes of policy impact analysis are not well defined. Indeed, some concepts were developed to define a scope of analysis but the definition of these concepts may vary a lot according to the study.

In this part of the report, we will act a definition for each concept found in the literature and will propose a coherent operational framework of analysis that permits better identifying the scope of our analysis.

A. Definition of general concepts to identify impacts on producers and consumers

Three types of impacts may occur – direct, indirect and induced impacts – at two different scale of analysis: gross and net.

Direct impact refers to socio-economic changes occurring in the production or consumption of goods and services directly linked to PAM implemented. For instance, a PAM oriented on the product P2 may impact the producer of P2 and/or the consumer of P2 in Figure 38. Those impacts may be analysed as **gross** impacts or **net** impacts. Gross impacts analysis implies that the impacts are strictly referred to the product P2 whereas net impacts consider effects on other goods and services (Figure 38).

Indirect impact concerns socio-economic effects occurring in the value chain of the product considered. Again, those impacts may be analysed as **gross** impacts or **net** impacts. Gross impacts analysis implies that the impacts are strictly analysed in the same value-chain as the product P2 whereas net impacts consider effects occurring in other value chains (Figure 38). For instance, in the example illustrated on Figure 38, gross indirect impacts correspond to impacts on the upstream and downstream value chain of P2. Upstream value chain corresponds to all the firms from the extraction of raw materials (MP) to the production of the set of inputs (P1) necessary to produce P2. Downstream value chain corresponds to all uses (including storage and distribution) of the product P2 as input of other production and final consumption.

Induced impact corresponds to the socio-economic impacts induced by the new socio-economic context. For instance, if a PAM results in extra-revenue for households – increasing their consumption

– it will lead to associated extra-production and extra-employment to ensure this extra-production. These effects are called induced impacts (Vito and Econotec. 2015).

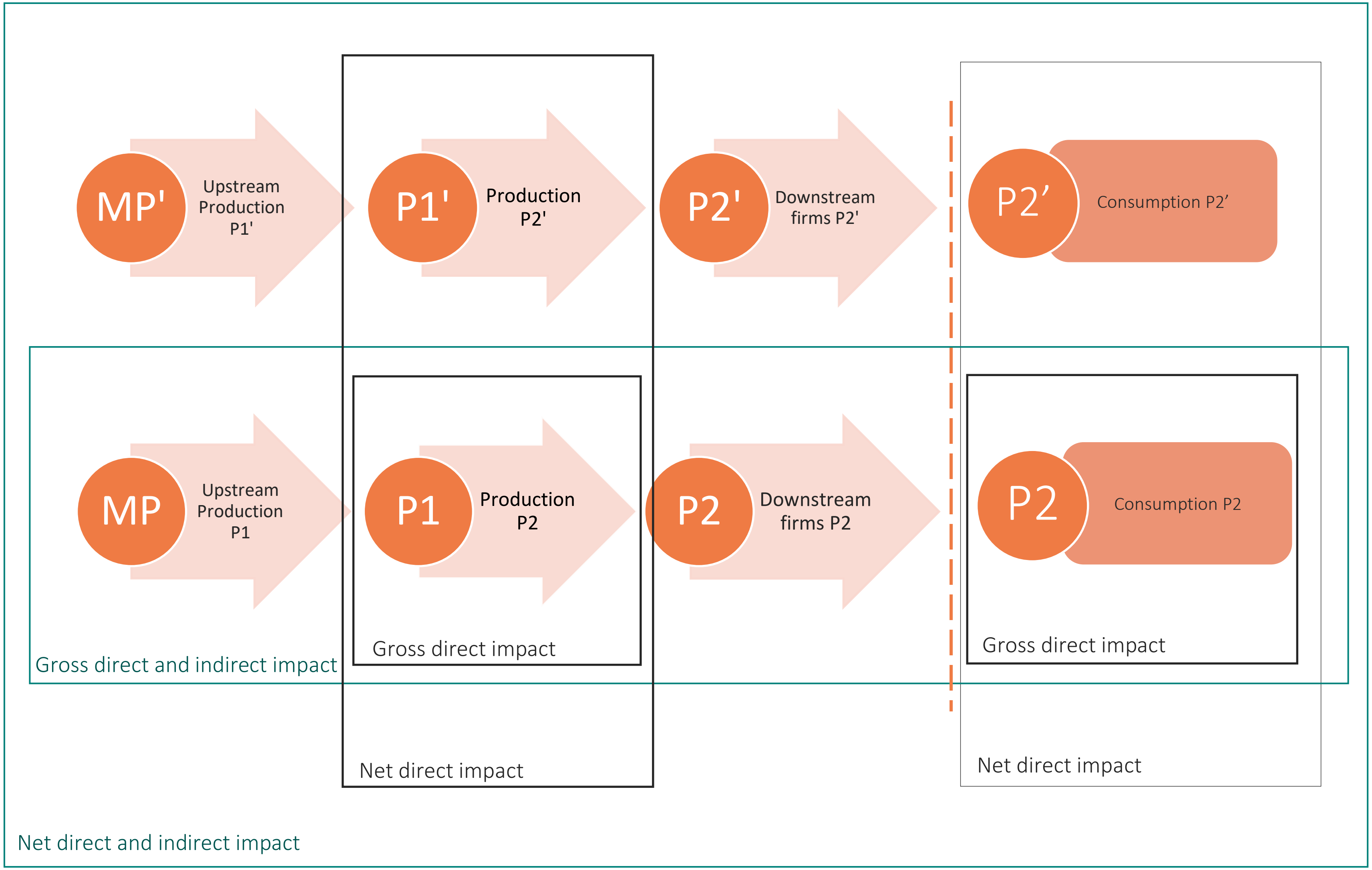


Figure 38 : Characterization of gross, net, direct and indirect impacts

The concept of gross, net, direct and indirect impacts are useful to depict the impacts that a PAM may have on the whole economy. These concepts may for instance be helpful to define the level of details of an analysis. Three categories of evaluations may be defined (Table 65):

- Quick evaluation, focusing on the evaluation of gross direct impacts: this category is suited to socio-economic evaluations that have to be conducted quickly and/or with few resources. This kind of evaluation is also suited to cases where a comparison between several alternatives for a specific PAM exists.
- Standard evaluation: this category concerns evaluation of gross direct to net direct and indirect impacts. However, net impacts refer only to the net impacts between substitutable goods and services, and not into the whole economy. This kind of assessment is suited to socio-economic evaluations of PAMs for which no complex macro-economic models exists but where time and data are available to conduct more detailed analysis.
- In-depth evaluation: this category refers to study assessing net direct, indirect and induced impacts on the whole economy. This kind of evaluation is suited to socio-economic evaluations for which a lot of resources are available: time, data, and modelling experts. Indeed, in-depth evaluations necessitate building and/or using complex models to apprehend the interlinkages between sectors and/or micro and macro levels.

Table 65 : Definition of categories of evaluations in relation to the impacts on producers and consumers considered

Impact on producers and/or consumers of goods and services impacts by the PAM	Categories of evaluation		
	Quick	Standard	In-depth
Gross direct	x	x	x
Gross indirect		x	x
Net direct		x^a	x^b
Net indirect		x^a	x^b
Induced impacts			x

Legend: x^a – between substitutable goods and services. ^{b} – between all markets.

However, used alone, these concepts fail to characterize/identify the socio-economic impacts under study as well as the actors impacted by the PAM. To cope with this, we propose linking the concepts of gross, net, direct and indirect impacts with theoretical concepts in the next section.

B. A framework to identify impacts on producers and consumers[25]

The framework we propose is organized in five main steps: (i) the gross direct impact identification and definition, (ii) the net direct impact identification and definition, (iii) the gross indirect impact identification and definition, (iv) the net indirect impact identification and definition, and (v) the identification of the impact that are relevant to consider in a standard approach.

Step 1: Gross direct impact identification and definition

This first step of the operational framework is composed of four sub-steps (Figure 39):

I. It is primordial to first clearly identify the goods and services impacted by the PAM. It has to be noted that a PAM may impact a range of goods and services for two main reasons: (i) because

[25] We propose a framework of evaluation that is very close to the economic theory, in order to allow for a better identification of the scope of the assessment. This framework is relevant for quick and standard evaluation as the in-depth evaluation category is out of scope of this project, given the time- and resource-consuming approaches it would need. Consequently, when we speak of net impacts, we only consider the net effect between substitutable goods and services.

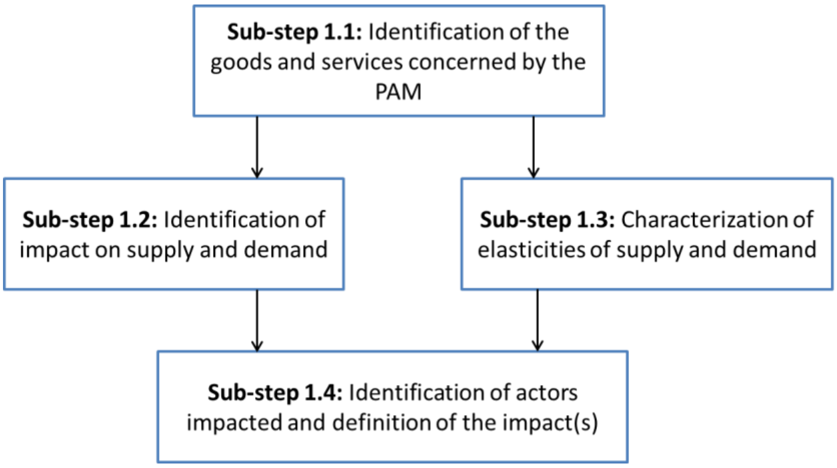
the PAM may directly concern various goods (as the PAM "Increase of excise duty on diesel" that also defines new rules for the gasolines excise duty) and/or (ii) because a good impacted may be directly linked with the use of another good as for instance diesel and cars or eco-design products and energy consumption. All these goods have to be identified in this first sub-step;

II. Second, the evaluator has to identify how the markets of the identified goods are impacted: is it the supply or the demand that is impacted by the PAM?

III. Third, the assessor has to characterize the elasticities of supply and demand;

IV. Finally, with the identification of the way each product is impacted (supply or demand) and with the assumptions made on elasticities, it is possible to identify which actors are impacted by the PAM (producer and/or consumer) and how.

Figure 39 : A four step guidelines to identify and define gross direct impacts of a PAM



The application of this step to a PAM permits having a global figure of assumptions made for the evaluation regarding the effects of the PAM on supply and demands of specific goods and services, and an information on the likely direction of changes for some general socio-economic indicators defined for producers and consumers. More concretely, we defined two types of contrasted and simplified impacts on supply and demand that may be identified for each product and service impact: (a) demand shift with inelastic supply and (b) supply shift with elastic demand (Figure 40).

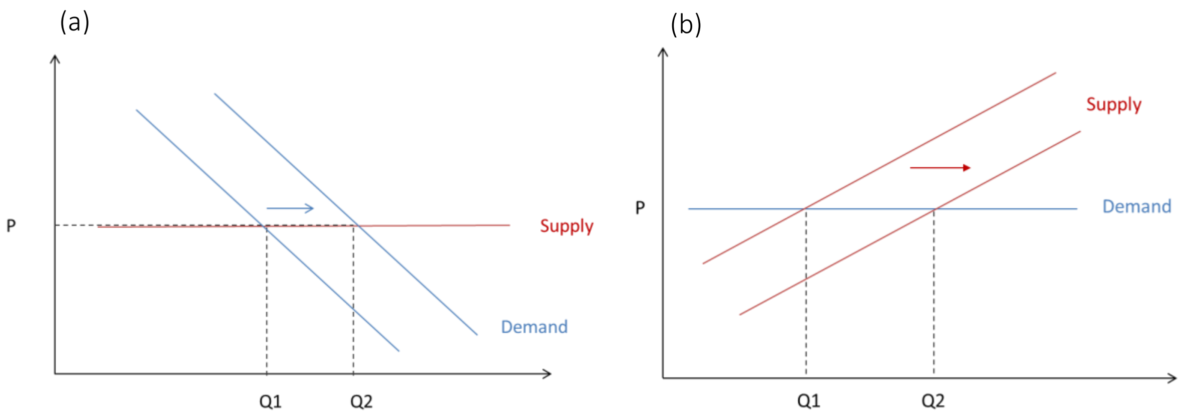


Figure 40 : Representation of two simplified and contrasted impacts on supply and demand

In both cases, the increase of demand or supply implies an increase of the total quantity purchased without any impact on prices. These simplified impacts concern indeed only a part of the economy. For instance, an increase of supply with an elastic demand may be assumed for the green electricity when new offshore winds are constructed. In fact, demand for electricity is quite inelastic but as we are focussing on green electricity, we may represent the effect on this specific product as showed in Figure

40 (b). An impact may indeed be observed on prices but as the objective of this work is to make first rough and simplified evaluations, the assumption of elastic demand may be done.

Then, the expected direction of changes on generic socio-economic indicators defining the impacts on producers and consumers are set. The objective is to set a likely direction without making any other assumption on the significance of the impacts. The generic socio-economic indicators used are defined in Section C.

Step 2: Net direct impact identification and definition

The identification of net direct impacts consists in identifying what is going to occur in the market of similar goods and services as those identified in step 1 (substitutable goods). The same sub-steps as in sub-step 1 may thus be followed to identify and define the net direct impacts of a PAM (Figure 39).

Step 3: Gross indirect impact identification and definition

In this step, the objective is to identify, for each good and service identified in step 1, if other producers from the value chain will be impacted by the eventual changes defined in step 1. If yes, these impacts must be defined (see section C for a definition of relevant socio-economic indicators to be considered).

Step 4: Net indirect impact identification and definition

The identification of net indirect impacts consists in identifying what is going to occur in the market of similar goods and services as those identified in step 2 (substitutable goods). For each substitutable goods and services, the same sub-steps as in sub-step 1 may thus be followed to identify and define the net indirect impacts of a PAM (Figure 39).

Step 5: Identification of relevant and evaluable indicators

The last step consists in analysing the impacts identified and defined in the previous steps and to discuss the more relevant impacts that have to be assessed to have a coherent evaluation of the impact of the PAMs.

C. Summary: impacts and socio-economic indicators considered

As a summary, Table 66 presents the main impacts and indictors that we propose to consider in our framework of evaluation.

The process of identification of the impacts on producers and consumers was defined in section 4.1. Regarding producers. the general impacts are defined with three generic socio-economic indicators: the economic activity, the gross margin and employment. The indicator "**Economic activity**" permits giving an information on the evolution of an activity (development or decrease). The quantification of this indicator is then specific to each PAM and the information available. It will generally be expressed as a percentage of evolution of another socio-economic indicator available as for instance, production costs or sales quantities. The indicator "**Gross Margin**" corresponds to the evolution of production costs compared to the sales prices of the product. The indicator "**Employment**" permits giving an information on the expected evolution of number of employees in a given sector.

Regarding the impacts on public sector, we distinguish two sources of costs and/or revenue: the impacts linked to the policy implementation and the impacts linked to the evolution of markets (Table 66). Regarding the **policy implementation** impacts, it could be only costs if it requires additional workforce or investments as for regulation PAMS for instance. In case of market-based instruments, both costs and benefits may arise: only costs if it concerns an economic incentive based on subsidies and essentially benefits if the economic incentive is based on taxes (but some costs may arise from the administrative implementation of the instrument). Regarding the impacts linked to the evolution of markets, it corresponds to the increase or decrease of taxes perceived from production and consumption units. This indicator, called "**Tax revenue**", corresponds thus to transfers. This information **must be interpreted**

carefully as a lower consumption of a specific good for consumers will imply a lower tax revenue for the public sector: this result must not be considered as a cost for the public sector as we may assume that the any savings made by a consumer will be spend in another good or service, bailing out the public sector.

Two last categories of impacts are considered: the externalities and other macroeconomic impacts. The **externalities** as environmental and welfare impacts may occur when implementing a public policy. This category of impacts concerns the household as consumers. It has to be noted that it may also impact the other consumers or a producer if the externality is specific to a production sector. We will not consider the impacts on these producers as it is too specific. We propose integrating in this framework four categories of **macro-economic impacts**: the impacts on supply. on demand. on prices and on the country performances. These macro-economic impacts concern producers and consumers.

To characterize the socio-economic impacts assessed, we recommended filling in the Table 67 with the products under study and socio-economic indicators assessed for each actor.

Table 66 : Impacts and socio-economic indicators

Impacts		Indicators
Impact on producers		• Economic activity (volume of production) • Gross margin (modification of costs of production without a modification of the associated sell prices – and vice-versa) • Employment
Impact on consumers		• Total quantity purchased • Purchase costs (of goods and services)
Impacts on public sector	Policy implementation impacts	• Investments costs • Administrative costs • (of which employment) • Subsidies • Tax
	Tax revenue impact	Impacts linked to the evolution of the markets
Externalities		Dependant on the PAM studied
Other macroeconomic indicators		Dependant on the PAM studied

Table 67 : summary of impacts considered

			Gross direct impact	Gross indirect impact	Net direct impact	Net indirect impact
Product 1	Producer	Producer P1				
		Upstream Prod.				
		Downstream Prod.				
	Consumer	Households				
		Industry				
		Public sector				
Product n	Producer	Producer Pn				
		Upstream Prod.				
		Downstream Prod.				
	Consumer	Households				
		Industry				
		Public sector				
Public sector	Policy implementation costs					
	Tax revenue impacts					
Externalities						
Other macro-economic indicators						

D.Conclusion

The framework of evaluation we propose is based on economic theory, ensuring a clear definition and justification of the socio-economic impacts considered. Furthermore, the detailed and step by step process of evaluation we propose permits ensuring:

- The use of a similar approach for making socio-economic evaluations of PAMs
- The consideration of the same socio-economic indicators between PAMs
- A transparent definition of assumptions and impacts evaluated/non-evaluated
- An intuitive framework easy to use for any evaluator

4.2. Implementation of the framework

In this section, the framework for socio-economic evaluation of policies and measures is implemented on a panel of federal climate PAMs. Owing to the limited time provided for the implementation of the framework, a lot of simplifying assumptions have been implemented. Therefore, the evaluations we made only give an order of magnitude of socio-economic impacts and should be regarded as first rough evaluation.

A summary of the results is provided in Table 68 for 2020 and in Table 69 for 2030. The assumptions made for these evaluations are explained in each PAM section.

PAM	Public sector			Producers			Households as consumers		Tertiary sector as consumers	
	Implementation costs (M€)	Savings as consumer (M€)	Tax revenue (M€)	Costs (M€)	Savings (M€)	Economic activity (%)	Costs (M€)	Savings (M€)	Costs (M€)	Savings (M€)
APP-T01	N	NA	NE	N	N	N	1.2	1.4	NA	NA
APP-T02	368.2	NA	-17.7	NE	NE	NE	0.0	405.9	NA	NA
APP-T03	NE	0.0	NA	N	N	N	NA	NA	NA	NA
APP-T04	NE	8.7	NA	N	N	N	NA	NA	NA	NA
EC - A05 - elec	see EC-A05 - non elec	NA	-729.3	N	N	N	0.0	1368.2	0.0	862.8
EC - A05 - non-elec	-1.0	NA	-130.1	N	N	N	0.0	245.7	0.0	92.5
EP-A01	330.7	NE	NE	2348.8	NE	0.5	NE	NE	NE	NE
TR-D01	N	NA	NE	736.2	NE	NE	NA	NA	NA	NA
XX-X04	N	N	54.0	N	N	N	0.0	-63.7	0.0	N

Table 68: Summary results of socio-economic impacts related to PAM implementation for 2020

Legend: N – Negligible. NE – impact not evaluated. NA – not applicable.

PAM	Public sector			Producers			Households as consumers		Tertiary sector as consumers	
	Implementation costs (M€)	Savings as consumer (M€)	Tax revenue (M€)	Costs (M€)	Savings (M€)	Economic activity (%)	Costs (M€)	Savings (M€)	Costs (M€)	Savings (M€)
APP-T01	N	NA	NE	N	N	N	1.2	1.4	NA	NA
APP-T02	NE	NA	NE	NE	NE	NE	0.0	NE	NA	NA
APP-T03	NE	NE	NA	N	N	N	NA	NA	NA	NA
APP-T04	NE	10.0	NA	N	N	N	NA	NA	NA	NA
EC - A05 - elec	see EC-A05 - non elec	NA	-1445.0	N	N	N	0.0	2685.4	0.0	1736.4
EC - A05 - non-elec	-1.0	NA	-309.0	N	N	N	0.0	582.8	0.0	220.2
EP-A01	0.0	NE	NE	7.8	NE	0.0	NE	NE	NE	NE
TR-D01	N	NA	NE	664.3	NE	NE	NA	NA	NA	NA
XX-X04	N	N	-584.6	N	N	N	0.0	832.1	0.0	N

Table 69 : Summary results of socio-economic impacts related to PAM implementation for 2030

Legend: N – Negligible. NE – impact not evaluated. NA – not applicable.

4.2.1. PAM « EC-A05 – Ecodesign – Non-electricity energy sources »

This PAM concerns Ecodesign products functioning with non-electricity energy sources. For ease of processing, we will refer to "Ecodesign products" as for eco-design products that are more efficient.

A. Identification and description of the socio-economic impacts

Impacts on consumers and producers

A.1. Step 1: Gross direct impacts identification and definition

The implementation of the Ecodesign Directive will impact two categories of products: the eco-design products and the associated energy consumption. In both cases, the impact on the market we focus on is a demand shift: increase of demand for the higher efficient products and decrease of demand for energy. In both cases, for simplicity we assume that the supply is inelastic, i.e. the demand shift will not affect the price of products (see Table 70).

Sub-steps	Product 1	Product 2
Sub-step 1 - Identification of goods and services concerned by the PAM	Ecodesign products	Energy consumption
Sub-step 2 - Identification of impact on supply and demand	Demand shift	Demand shift
Sub-step 3 - Characterization of elasticities of supply and demand	Supply inelasticity	Supply inelasticity

Table 70: Presentation of results of sub-steps 1, 2 and 3

The last sub-step consists in identifying and defining the impacts on producers and consumers of products identified in sub-step 1 in the conditions defined in sub-step 2 and 3 (Table 71).

We assume there is no additional cost of production for the producers of the eco-design products due to the new legislation: the gross margin is thus expected to be the same. However, we assume an increase of economic activity given that a higher volume of production will be needed to satisfy the increasing demand.

Regarding the consumers of eco-design products, additional costs may arise from the higher investments needed for buying more efficient eco-design products. However, Vito and Econotec (2015) argue that the Ecodesign Directive do not result in an increase of the equipment price compared to business as usual.

With regards to energy consumption, the opposite impact may be observed: a decrease in total consumption of energy and in turn a decrease of economic activity (and thus of employment) for the producer of energy. Again, we assume that the gross margin and the purchase costs are not affected by the PAM.

Gross direct impacts	Ecodesign products	Energy consumption
Impact on producers		
• Economic activity (volume of production)	↗	↘
• Gross margin (modification of costs of production without a modification of the associated sell prices – and vice-versa)	=	=
• Employment	↗	↘
Impact on consumers		
• Total quantity purchased	↗	↘
• Purchase costs (of goods and services)	=	=

Table 71: Presentation of results of sub-step 4

Legend: ↗ – Increasing impact. ↘ – Decreasing impact. = – No impact.

A.2. Step 2: Net direct impact identification and definition

Net direct impacts concern potential substitution effects related to the impact on products identified in A.1. i.e. the eco-design products and the energy consumption. Regarding the more efficient products. there is a substitution effects with similar products that are not more efficient products. On the contrary, there is no substitution effect regarding energy consumption: it is a decrease of consumption without an increase of consumption of other energy resources.

As for the eco-design products, the impact on similar non-ecodesign products corresponds to a demand shift, but to the left in this case, while the supply side is assumed to be inelastic. The related expected impacts on consumer and producer are presented in Table 72.

Net direct impacts	Non -Ecodesign products
Impact on producers	
• Economic activity (volume of production)	↘
• Gross margin (modification of costs of production without a modification of the associated sell prices – and vice-versa)	=
• Employment	↘
Impact on consumers	
• Total consumption	↘
• Purchase costs (of goods and services)	=

Table 72: Definition of net direct impacts on producers and consumers

Legend: ↗ – Increasing impact. ↘ – Decreasing impact. = – No impact.

A.3. Step 3: Gross indirect impact identification and definition

Gross indirect impacts correspond to the propagation of impacts identified in A.1 into the value chain of identified products, i.e. the eco-design products and energy. As in both cases an impact is expected on the economic activity, this impact will be transferred proportionally to the upstream and downstream firms.

For instance, a decrease of the economic activity of the producers in the sector of refinery and gas distribution may be expected given that this PAM will imply lower energy consumption. As this energy (coal, gas and oil) is imported, we could also expect a positive impact on the balance of payments.

A.4. Step 4: Net indirect impact identification and definition

Net indirect impacts correspond to the propagation of impacts identified in A.2 into the value chain of the identified products, i.e. the non-ecodesign products. As an impact is expected on the economic activity, this impact will be transferred proportionally to the upstream and downstream firms.

A.5. Step 5: Summary of impacts of the PAM on consumers and producers.

A summary of the impact of the PAM on the consumers and producers is presented in Table 73.

Box 1: Potential induced impacts

It has also to be noted that two kinds of induced impacts (rebound effects) may occur: (1) the consumer may consume more energy (for heating for instance) because he knows he is saving money with the eco-design products (operational costs) and (2) the consumer may decide to spend the money saved elsewhere. These behaviours will also imply an induced effect for the producers. In the first case, it will counterbalance the decrease in economic activity of the energy producers/distributors identified before. In the second case, it will enhance the economic activity of producers (for potentially all kind of sectors). In the same way, the public sector could recover the indirect implementation costs of the PAM by retrieving taxes on the induced consumption of consumers. In our evaluation, we assume there are no rebound effects because we do not have enough data to make any assumption on the consumer behaviour.

			Gross direct impact	Gross indirect impact	Net direct impact	Net indirect impact
Product 1: Ecodesign product	Producer	Producer P1	↗ EA. ↗ E		↘EA. ↘E	
		Upstream Prod.		↗ EA. ↗ E		↘EA. ↘E
		Downstream Prod.		↗ EA. ↗ E		↘ EA. ↘ E
	Consumer	Households	↗Q		↘Q	
		Industry	↗Q		↘Q	
		Public sector	↗Q		↘Q	
Product 2 : Energy consumpti on	Producer	Producer P2	↘EA. E			
		Upstream Prod.		↘EA. E		
		Downstream Prod.		↘EA. E		
	Consumer	Households	↘Q			
		Industry	↘Q			
		Public sector	↘Q			

Table 73: Summary of impacts on producers and consumers

Legend: ↗ – Increase. ↘ – Decrease. EA – Economic Activity. E – Employment. Q - Quantity

Impacts on public sector

Two categories of impacts are distinguished for the public sector, the policy implementation costs and the tax revenue impacts.

Regarding the policy implementation costs, the implementation of the PAM will imply a need to enforce the directive and its implementing regulations and to control the compliance of producers to the regulation. Mobilization of existing personnel resources will not be sufficient and new jobs will need to be created in the field of Market Surveillance. This implementation will thus imply a cost that will be related to the working time that will be necessary for the implementation and a cost for testing appliances. Both impacts are assessed in the next section. No specific investment in equipment will be needed.

Regarding the tax revenue impacts, as discussed in section 4.2.1.A, only the net impact on energy consumption is considered relevant. The decrease of energy consumption identified will decrease the revenue linked to the tax on energy for the public sector. This impact will be evaluated in the next sub-section.

Summary of impacts considered

A summary of the socio-economic impacts considered in our evaluation to run a net direct and indirect impacts assessment are presented in Table 74.

Regarding the eco-design products, as the increase in quantity sold is assumed to be proportional[26] to the decrease of quantity of conventional equivalent products sold (and thus of the subsequent economic activity), we assume that the net direct and indirect impact of the PAM on producers of eco-design and similar products will be neutral. Regarding consumers, the same assumptions may be done regarding the total quantity purchased, but as state before, a higher price for more efficient eco-design products may be expected. However, Vito and Econotec (2015) argue that the Ecodesign Directive does not result in an increase of the equipment price compared to business as usual. This argument may be consolidated by an estimate made by the US department of energy for solar water heater. In their evaluation, even if they consider a higher price for the energy efficient product, they conclude that the payback time is 1.5 years[27]. By assuming the same payback level for the other equipment, we decided not to treat these impacts as a priority given that they appear to be negligible with regards to our timeframe of evaluation.

Regarding the energy consumption, the decrease of the quantity consumed by eco-design products is not compensated by an increase of consumption by other products as an indirect impact (some induced impacts may however occur – See Box 1). Regarding the impacts on production, we however consider the PAM will not significantly impact the energy sector (and thus the level of economic activity and of employment). However, for individual consumers, the impact may be significant.

As a conclusion, to run a net direct and indirect impact assessment of the PAM "Ecodesign" on consumers and producers, the relevant indicators to assess are the savings related to the decrease of consumption of energy by using eco-design products, the administrative and employment costs for the public sector and the impact on the tax revenue of public sector.

			Net direct and indirect impacts
	Producer	Producer P1	=

[26] Indeed, we assume that their purchasing behaviour is not impacted by the PAM. In other words, the PAM will not affect change the replacement rate of products.

[27] http://energy.gov/energysaver/estimating-cost-and-energy-efficiency-solar-water-heater

Product 1: Ecodesign product		Upstream Prod.	=
		Downstream Prod.	=
	Consumer	Households	N
		Industry	N
		Public sector	N
Product 2: Energy consumption	Producer	Producer P2	N
		Upstream Prod.	N
		Downstream Prod.	N
	Consumer	Households	Evaluated (ES)
		Industry	Evaluated (ES)
		Public sector	N
Public sector	Policy implementation costs		Evaluated (AC & E)
	Tax revenue impacts		Evaluated
Externalities			NA
Other macro-economic indicators			NA

Table 74: Assessed impacts of the Ecodesign Regulation on producers. consumers and the public sector

Legend: = - Neutral impact. N – Negligible impact. ES – Economic savings. AC – impact on administrative costs. E – impact on employment. NA – Non-Applicable.

B. Methodology of evaluation

The methodology of evaluation of the five socio-economic impacts identified is described by actor.

Regarding the **consumers**, we assessed the total savings – related to the decrease in energy consumption – by distinguishing the households and the other consumers:

- For **households,** the benefits correspond to the avoided costs coming from the decrease of energy consumption, i.e. their avoided energy consumption multiplied (EC^H) by the price for household (p_T^H) all taxes included (Table 75).
- For **other consumers** (tertiary sector), the benefits also correspond to the avoided costs coming from the decrease of energy consumption, i.e. their avoided energy consumption (EC^O) multiplied by the price for the tertiary sector (p_{HVAT}^O), VAT excluded as they retrieve it (Table 75).

Regarding the **public sector**, the impact related to the decrease of energy consumption correspond to the <u>taxes</u> that would have been paid by the consumers if they had not consumed less energy by using eco-design products (Table 75). Concretely, we estimated these costs by identifying the part of the energy price that correspond to the taxes perceived by the public sector and the decrease of energy consumption related to the use of eco-design products. As the prices are related to the type of consumer, we distinguished the decrease of consumption made by the households (EC^H) and the other consumers (EC^O).. Regarding the households, this price corresponds to the difference between the price all taxes included (p_T^H) and the price all taxes excluded (p_{HT}^H) for household. Regarding the other consumers, the price to the difference between the price VAT excluded (p_{HVAT}^O) (as the tertiary sector retrieve the VAT) and the price all taxes excluded (p_{HT}^O) for the tertiary sector.

With regards to the PAM <u>implementation costs,</u> employment costs and other administrative costs are necessary to run additional verification tests. For employment costs, a number of additional employers has to be identified and multiplied by the subsequent salary needed. The same hypotheses as detailed in the 2017 report are taken. A need for 1 supervising and coordinating Inspector (class A) and 4 Inspectors (Class B) for field work (shop visits, sample taking) was estimated from 2017. It was estimated in 2017 that less than one FTE was employed on market surveillance on Ecodesign. It has to be taken into account that the products here are only part of all energy related products covered by Ecodesign regulations.

For other administrative costs, the number of additional verification tests has to be estimated, as well as their average costs. Again, the same hypotheses as detailed in the 2017 report are taken A linear increase of additional verification tests was needed from 100 in 2017 to 200 in 2020. Verification tests for appliances cost on average €4.000 (including VAT and logistical costs). Tested appliances do not need to be purchased and sampling can be done for free.

Identified impacts		Method
Public sector		
Implementation costs	Employment costs	- [$J^{FTE-A}*P^{FTE-A} + J^{FTE-B}*P^{FTE-BE}$]
	Other administrative costs	- [$VT*P^{VT}$]
Tax revenue impacts		- [$EC^{H}*(p_T^H - p_{HT}^H) + EC^{O}*(p_{HVAT}^O - p_{HT}^O)$]
Consumers		
Household (€)	Operational impacts	+ $EC^{H}*p_T^H$
Others (€)	Operational impacts	+ $EC^{O}*p_{HVAT}^O$

Table 75: Method of estimation of the socio-economic impacts identified

Legend: EC^H – estimated decrease of energy consumption for household. EC^O – estimated decrease of energy consumption for other consumers (tertiary sector). – energy price for household (all taxes excluded). – energy price for other consumers (all taxes excluded). – energy price for household (all taxes included). – energy price for other consumers (VAT excluded). J^{FTE} – Number of FTE job creation (class A or B).P^{FTE} – Cost for a FTE job (class A or B). VT – Number of verification tests. P^{VT} – Cost of verification tests.

The data used to make theses evaluations are presented in Table 76. The data on energy consumption comes from our own evaluations (see previous section). The data on past energy prices come from Eurostat, from a technical report published by the Walloon Public Service and from the DG Statistics (EPMECME - DGSIE). The data on future energy prices were calculated by applying the same coefficient of evolution than the future costs of energy estimated by the FPB. It has to be noted that we could not find the detail of the prices of gasoil and coal: we only have the price all taxes and levies included. Therefore, the benefits of the other consumers are overestimated and the costs for the public sector underestimated.

Identified impacts	Data		Source
Public sector > Tax revenue impacts & Consumers > Operational costs	Energy consumption		Our evaluation (see Section "Emission reduction")
	Energy price	Natural gas	Eurostat. FPB
		Gasoil	DG statistics
		Coal	Report Wallon Public Service (DGO4) – Bilans énergétiques 2014. volet « Facture énergétique » 2016.
Public sector > PAM implementation > Employment costs	Job creation (FTE) Salary		Personal communication FPS envi (product policy). Statbel

Public sector > PAM implementation > Other administrative costs	Increase of operational impact (verification test) Cost of the operational impact	Personal communication FPS envi (product policy)

Table 76: Data sources

C. Results

The impacts of the Ecodesign Directive on consumer expenditures in Belgium is presented in Figure 41. The Ecodesign Directive may imply savings from 582.8 M€ and 220.2 M€ by 2030 to 748.4 M€ and 275.7 M€ by 2040 for households and the tertiary sector respectively.

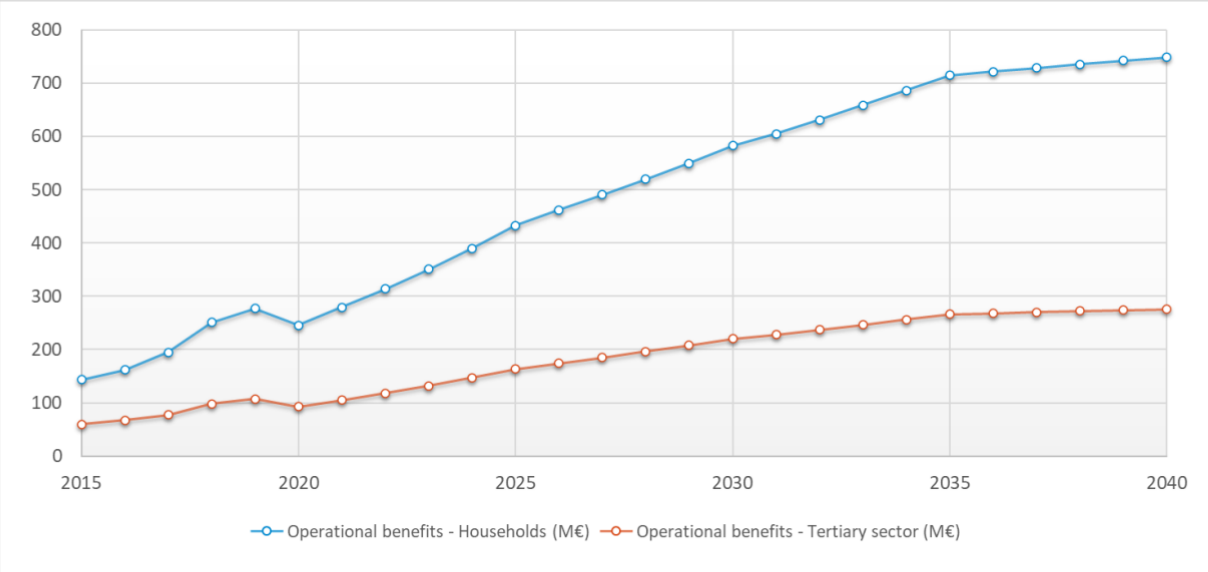


Figure 41: Socio-economic impacts of the Ecodesign Directive on consumers (non-electricity energy sources)

The impacts of the Ecodesign Directive on the public sectors expenditures are presented in Figure 42. First, we can observe that the implementation costs correspond to 1M€ annually[28], of which 19% corresponds to employment costs and 81% verification test costs. Second, higher impacts are expected due to a decrease in tax revenue (from 147.9M€ in 2021 to 309M€ in 2030). However, these costs have to be interpreted carefully because induced impacts may be expected that would counterbalance this tax revenue decrease (See Box 1).

[28] 0.5M€ would have be more realistic but ideally a higher budget should effectively be necessary. This cost cover Ecodesign and Energy Labelling (FPS envi and FPS econ). This cost also covers both electricity and non-electricity energy sources.

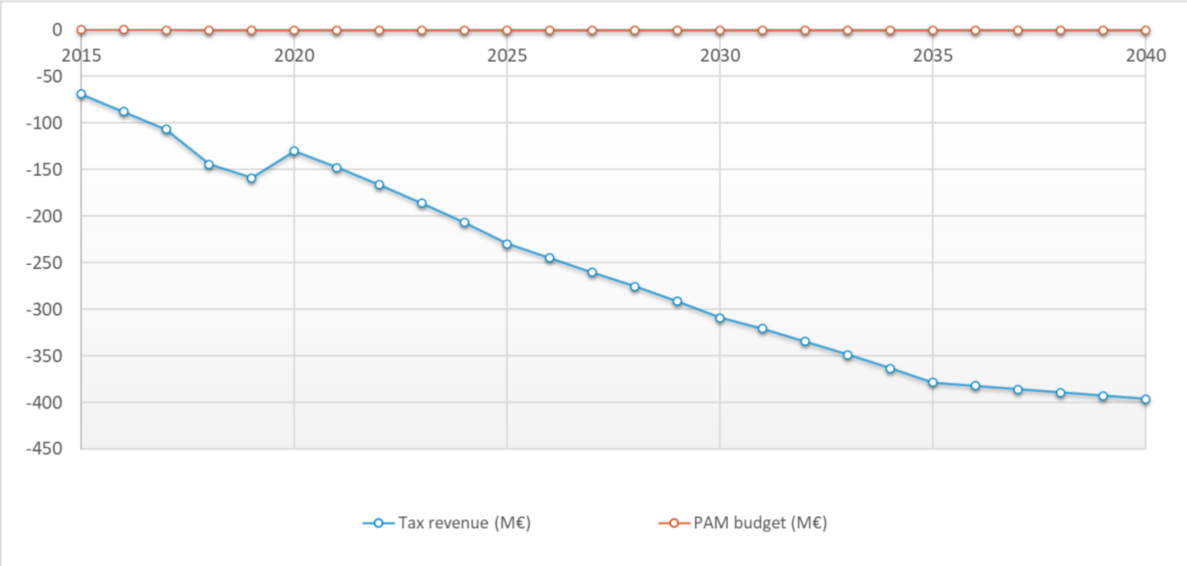


Figure 42: Socio-economic impacts of the Ecodesign Directive on public sector

4.2.2. PAM « EC-A05 – Ecodesign – Electricity energy source »

This PAM concerns Ecodesign products functioning with electricity. For ease of processing, we will refer to "Ecodesign products" as for eco-design products that are more efficient.

A. Identification and description of the socio-economic impacts

Impacts on consumers and producers

A.1. Step 1: Gross direct impacts identification and definition

The implementation of the Ecodesign Directive will impact two categories of products: the eco-design products and the associated energy consumption (Table 77). In both cases, the impact on the marker can be translated as a demand shift: increase of demand for the eco-design products and decrease of demand for energy. In both cases, we assume that the supply is inelastic, i.e. the demand shift will not affect the price of products.

Sub-steps	Product 1	Product 2
Sub-step 1 - Identification of goods and services concerned by the PAM	Ecodesign products	Energy consumption
Sub-step 2 - Identification of impact on supply and demand	Demand shift	Demand shift
Sub-step 3 - Characterization of elasticities of supply and demand	Supply inelasticity	Supply inelasticity

Table 77: Presentation of results of sub-steps 1, 2 and 3

We assume that no additional cost of production for the producers of the eco-design products may arise due to the new legislation: the gross margin is thus expected to be the same. However, we assume an increase of economic activity given that a higher volume of production will be needed to satisfy the increasing demand (Table 78).

Regarding the consumers of eco-design products, we assume that the purchase costs are not higher. Additional costs may arise from the higher investments needed for buying eco-design products. However, Vito and Econotec (2015) argue that the Ecodesign Directive do not result in an increase of the equipment price compared to business as usual (Table 78).

With regards to the energy consumption, the opposite impact may be observed: a decrease of economic activity for the producer of energy (of which employment) and decrease total consumption of consumers. Again, we assume that the gross margin and the purchase costs are not affected by the PAM (Table 78).

Gross direct impacts	Ecodesign products	Energy consumption
Impact on producers		
• Economic activity (volume of production)	↗	↘
• Gross margin (modification of costs of production without a modification of the associated sell prices – and vice-versa)	=	=
• Employment	↗	↘
Impact on consumers		
• Total quantity purchased	↗	↘
• Purchase costs (of goods and services)	=	=

Table 78: Presentation of results of sub-steps 4

Legend: ↗ – Increasing impact. ↘ – Decreasing impact. = – No impact.

A.2. Step 2: Net direct impact identification and definition

Net direct impacts concern potential substitution effects related to the impact on products identified in step 1, i.e. the eco-design products and the energy consumption. Regarding the eco-design products, there is a substitution effects with similar products that are not eco-design products. On the contrary, there is no substitution effect regarding energy consumption: it is a decrease of consumption without an increase of consumption of other resources.

As for the eco-design products, the impact on similar non-ecodesign products corresponds to a demand shift, but to the left in this case, while the supply side is assumed to be inelastic. The related expected impacts on consumer and producer are presented in Table 79.

Net direct impacts	Non -Ecodesign products
Impact on producers	
• Economic activity (volume of production)	↘
• Gross margin (modification of costs of production without a modification of the associated sell prices – and vice-versa)	=
• Employment	↘
Impact on consumers	
• Total consumption	↘
• Purchase costs (of goods and services)	=

Table 79: Definition of net direct impacts on producers and consumers

A.3. Step 3: Gross indirect impact identification and definition

Gross indirect impacts correspond to the propagation of impacts identified in A.1 into the value chain of identified products, i.e. the eco-design products and energy. As in both cases an impact is expected on the economic activity, this impact will be transferred proportionally to the upstream and downstream firms.

For instance, a decrease of the economic activity of the producers in the sector of refinery and gas distribution may be expected given that this PAM will imply lower energy consumption. As this energy (coal, gas and oil) is imported, we could also expect a positive impact on the balance of payments.

A.4. Step 4: Net indirect impact identification and definition

Net indirect impacts correspond to the propagation of impacts identified in A.2 into the value chain of the identified products, i.e. the non-ecodesign products. As an impact is expected on the economic activity, this impact will be transferred proportionally to the upstream and downstream firms.

A.5. Step 5: Summary of impacts on consumers and producers

A summary of the impact of the PAM on the consumers and producers is presented in Table 80.

Box 2: Potential induced impacts

It also has to be noted that two kind of induced impacts (rebound effects) may occur: (1) the consumer may consume more energy (e.g. for heating) because one knows one is saving money with the eco-design products (operational costs) and (2) the consumer may decide to spend the money saved elsewhere. These behaviours will also imply an induced effect for the producers. In the first case, it will counterbalance the decrease in economic activity of the energy producers/distributors identified before. In the second case, it will enhance the economic activity of producers (for potentially all kind of sectors). In the same way, the public sector could recover the indirect implementation costs of the PAM by retrieving taxes on the induced consumption of consumers. In our evaluation, we assume there are no rebound effects because we do not have enough data to make any assumption on the consumer behaviour.

Table 80 : Summary of impacts on producers and consumers

			Gross direct impact	Gross indirect impact	Net direct impact	Net indirect impact
Product 1: Ecodesign product	Producer	Producer P1	↗ EA. ↗ E		↘EA. ↘E	
		Upstream Prod.		↗ EA. ↗ E		↘EA. ↘E
		Downstream Prod.		↗ EA. ↗ E		↘ EA. ↘ E
	Consumer	Households	↗Q		↘Q	
		Industry	↗Q		↘Q	
		Public sector	↗Q		↘Q	
Product 2 : Energy consumption	Producer	Producer P2	↘EA. E			
		Upstream Prod.		↘EA. E		
		Downstream Prod.		↘EA. E		
	Consumer	Households	↘Q			
		Industry	↘Q			
		Public sector	↘Q			

Legend: ↗ – Increase. ↘ – Decrease. EA – Economic Activity. E – Employment. Q - Quantity

Impacts on public sector

Two categories of impacts are distinguished for the public sector: the policy implementation costs and the tax revenue impacts.

Regarding the policy implementation costs, the implementation of the PAM will imply a need to enforce the directive and its implementing regulations and to control the compliance of producers to the regulation. Mobilization of existing staff resources will not be sufficient and new jobs will need to be created in the field of Market Surveillance. These implementation costs are yet considered in 4.2.1.A.

Regarding the tax revenue impacts. as discussed in section 4.2.1.A. only the net impact on energy consumption is considered relevant to study. The decrease of energy consumption identified will decrease the revenue linked to the tax on energy for the public sector. This impact will be evaluated in the next sub-section.

Summary of impacts considered

A summary of the socio-economic impacts considered in our evaluation to run a net direct and indirect impacts assessment are presented in Table 81.

Regarding the eco-design products, as the increase in quantity sold is assumed to be proportional[29] to the decrease of quantity sold of conventional equivalent products (and thus of the subsequent economic activity), we assume that the net direct and indirect impact of the PAM on the consumers and producers of eco-design and similar products will be neutral.

Regarding the energy consumption, the decrease of the quantity consumed is not compensated by an increase of consumption as an indirect impact (some induced impacts may however occur – See Box 2). Regarding the impacts on production, we however consider that the PAM will not significantly impact the energy sector (and thus the level of economic activity and of employment). However, for individual consumers, the impact may be significant.

As a conclusion, to run a net direct and indirect impact assessment of the PAM "Ecodesign" on consumers and producers, the relevant indicators to assess are the savings made related to the decrease of consumption of energy by using eco-design products. We will distinguish two kinds of consumers: industries and households.

[29] Indeed, we assume that the purchasing behaviour is not impacted by the PAM. In other words, the PAM will not affect the replacement rate of products.

			Net direct and indirect impacts
Product 1: Ecodesign product	Producer	Producer P1	=
		Upstream Prod.	=
		Downstream Prod.	=
	Consumer	Households	=
		Industry	=
		Public sector	=
Product 2: Energy consumptio n	Producer	Producer P2	N
		Upstream Prod.	N
		Downstream Prod.	N
	Consumer	Households	↘Q
		Industry	↘Q
		Public sector	N
Public sector	Policy implementation costs		↗AC. ↗E
	Tax revenue impacts		↘
Externalities			NA
Other macro-economic indicators			NA

Table 81: Assessed impacts of the Ecodesign Regulation on producers, consumers and the public sector

Legend: = - Neutral impact. N – Negligible impact. Q – impact on quantity consumed. AC – impact on administrative costs. E – impact on employment. NA – Non-Applicable. ↗ – increasing impact. ↘ – decreasing impact

B. Methodology of evaluation

The methodology of evaluation of the five socio-economic impacts identified is described by actor.

Regarding the **consumers**, we assessed the total savings – related to the decrease in energy consumption – by distinguishing the households and the other consumers:

- For **households,** the benefits correspond to the avoided costs coming from the decrease of energy consumption, i.e. their avoided energy consumption multiplied (EC^H) by the price for household (p_T^H) all taxes included (Table 82).
- For **other consumers** (tertiary sector), the benefits also correspond to the avoided costs coming from the decrease of energy consumption, i.e. their avoided energy consumption (EC^O) multiplied by the price for the tertiary sector (p_{HVAT}^O), VAT excluded as they retrieve it (Table 82).

Regarding the **public sector**, the impact related to the decrease of energy consumption correspond to the taxes that would have been paid by the consumers if they had not consumed less energy by using eco-design products (Table 82). Concretely, we estimated these costs by identifying the part of the energy price that correspond to the taxes perceived by the public sector and the decrease of energy consumption related to the use of eco-design products. As the prices are related to the type of consumer, we distinguished the decrease of consumption made by the households (EC^H) and the other consumers (EC^O).. Regarding the households, this price corresponds to the difference between the price all taxes included (p_T^H) and the price all taxes excluded (p_{HT}^H) for household. Regarding the other consumers, it is equal to the difference between the price VAT excluded (p_{HVAT}^O) (as the tertiary sector retrieve the VAT) and the price all taxes excluded (p_{HT}^O) for the tertiary sector.

With regards to the PAM implementation costs, employment costs and other administrative costs are necessary to run additional verification tests. For employment costs, a number of additional employers has to be identified and multiplied by the subsequent salary needed. The same hypotheses as detailed in the 2017 report are taken. A need for 1 supervising and coordinating Inspector (class A) and 4 Inspectors (Class B) for field work (shop visits, sample taking) was estimated from 2017. It was estimated in 2017 that less than one FTE was employed on market surveillance on Ecodesign. It has to be taken into account that the products here are only part of all energy related products covered by Ecodesign regulations.

For other administrative costs, the number of additional verification tests has to be estimated, as well as their average costs. Again, the same hypotheses as detailed in the 2017 report are taken A linear increase of additional verification tests was needed from 100 in 2017 to 200 in 2020. Verification tests for appliances cost on average €4.000 (including VAT and logistical costs). Tested appliances do not need to be purchased and sampling can be done for free.

Even if the socio-economic impacts for the PAM “Ecodesign” were dissociated between electricity and non-electricity products, implementation costs apply for the PAM as a whole. Therefore, we do not present estimates of these costs in this section as they can be found in section 4.2.1.C .

Identified impacts		Method
Public sector		
Implementation costs	Employment costs	- [$J^{FTE-A}*P^{FTE-A} + J^{FTE-B}*P^{FTE-BE}$]
	Other administrative costs	- [$VT*P^{VT}$]
Tax revenue impacts		- [$EC^{H}*(p_T^H - p_{HT}^H) + EC^{O}*(p_{HVAT}^O - p_{HT}^O)$]
Consumers		
Household (€)	Operational impacts	+ $EC^{H}*p_T^H$
Others (€)	Operational impacts	+ $EC^{O}*p_{HVAT}^O$

Table 82: Method of estimation of the socio-economic impacts identified

Legend: EC^H – estimated decrease of energy consumption for household. EC^O – estimated decrease of energy consumption for other consumers (tertiary sector). – energy price for household (all taxes excluded). – energy price for household (all taxes included). – energy price for other consumers (VAT excluded). J^{FTE} – Number of FTE job creation (class A or B).P^{FTE} – Cost for a FTE job (class A or B). VT – Number of verification tests. P^{VT} – Cost of verification tests.

The data used to make theses evaluations are presented in Table 83. The data on energy consumption comes from our own evaluations (see previous section). The data on past energy prices come from Eurostat and technical report of FPS[30]. The data on future energy prices were calculated by applying the same coefficient of evolution than the future costs of energy estimated by the FPB. It has to be noted that we could not find the detail of the prices of gasoil and coal: we only have the price all taxes and levies included. Therefore, the benefits of the other consumers are overestimated and the costs for the public sector underestimated.

Identified impacts	Data		Source
Public sector > Tax revenue impacts & Consumers > Operational costs	Energy consumption		Our evaluation (see Section “Emission reduction”)
	Energy price	Electricity	Eurostat. FPB
Public sector > PAM implementation > Employment costs	Job creation (FTE) Salary		Personal communication FPS envi. Statbel
Public sector > PAM implementation > Other administrative costs	Increase of operational impact (verification test) Cost of the operational impact		Personal communication FPS envi

Table 83: Data sources

[30] https://www.plan.be/uploaded/documents/201805171245060.WP_1805_11575.pdf, retrieved on 12 April 2021.

C. Results

The impacts of the Ecodesign Directive on consumer costs is presented in Figure 43. The Ecodesign Directive may imply savings for consumers of 4 420 M€ in 2030 and 4 850 M€ in 2040. The decrease of tax revenue from lower electricity consumption for the public sector is of 1 445M€ in 2030 and 1 585 M€ in 2040.

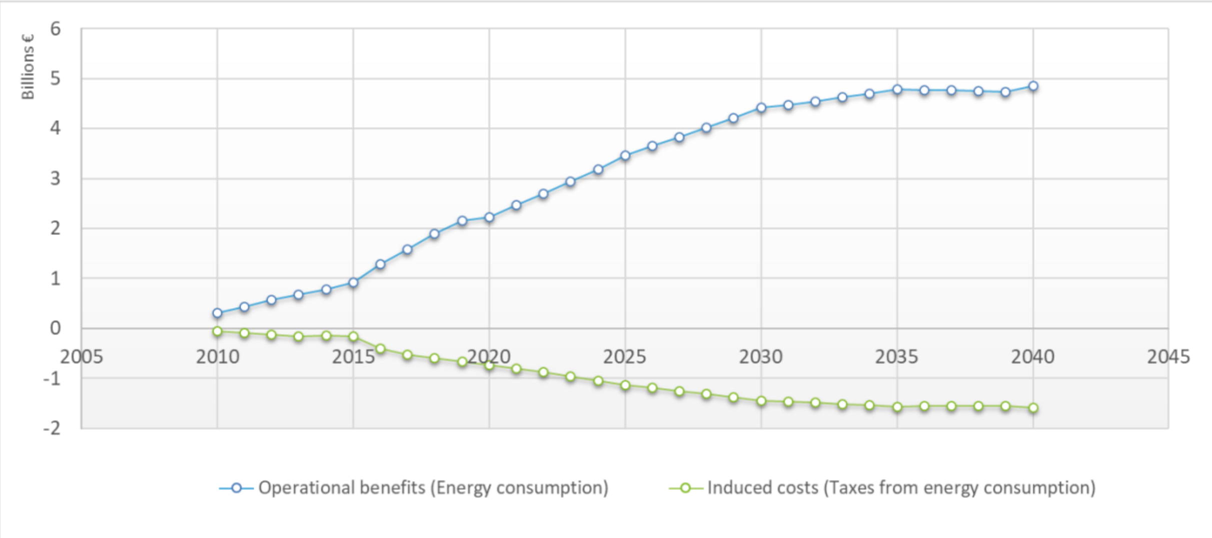


Figure 43: Socio-economic impacts of the Ecodesign Directive on consumers and public sector (Electricity energy source)

4.2.3. PAM « EP-A01 – Offshore wind »

With a view to ensuring the placing on the market of a minimum volume of green electricity, this PAM corresponds to a subsidy system.

A. Identification and description of the socio-econmic impacts

Impacts on consumers and producers

A.1. Step 1: Gross direct impacts identification and definition

As presented in step 1 from section PARTIE A : 4.1.2.B. the identification and definition of the gross direct impacts of a PAM may be done by a four sub-steps process. The results of the three first sub-steps are presented in Table 84.

This PAM will impact one kind of product "the green electricity production" through the construction of offshore winds. Its implementation is expected to increase the supply of green electricity. We assume an elastic demand.

Sub-steps	Product 1
Sub-step 1 - Identification of goods and services concerned by the PAM	Offshore wind construction/Green electricity production
Sub-step 2 - Identification of impact on supply and demand	Increase of supply
Sub-step 3 - Characterization of elasticities of supply and demand	Demand elasticity

Table 84: Presentation of results of sub-steps 1, 2 and 3

The economic activity of producers will increase proportionally to the construction of new offshore wind farms (Table 85). We assume that the gross margin will be constant on the long run. In the same way, we assume no impact on sell prices (and thus on purchase costs for consumers). However, the total consumption of green electricity will increase.

Gross direct impacts	Offshore wind Green electricity production
Impact on producers	
• Economic activity (volume of production)	↗
• Gross margin (modification of costs of production without a modification of the associated sell prices – and vice-versa)	=
• Employment	↗
Impact on consumers	
• Total quantity purchased	↗
• Purchase costs (of goods and services)	N

Table 85: Presentation of results of sub-step 4

Legend: ↗ – Increasing impact. ↘ – Decreasing impact. N – Negligible impact. = – No impact.

A.2. Step 2: Net direct impact identification and definition

Net direct impacts concern potential substitution effects related to the impact on products identified in A.1. i.e. the green electricity produced by offshore wind farms. We can expect an impact on producers and consumers of other sources of electricity. Again, we do not consider an impact on prices.

The related expected impacts on consumer and producer are presented in Table 86.

Net direct impacts	
Impact on producers	
• Economic activity (volume of production)	↘
• Gross margin (modification of costs of production without a modification of the associated sell prices – and vice-versa)	N
• Employment	↘
Impact on consumers	
• Total quantity purchased	↘
• Purchase costs (of goods and services)	N

Table 86: Definition of net direct impacts on producers and consumers

Legend: ↗ – Increasing impact. ↘ – Decreasing impact. N – Negligible impact. = – No impact.

A.3. Step 3: Gross indirect impact identification and definition

Gross indirect impacts correspond to the propagation of impacts identified in A.1 into the value chain of identified products, i.e. the production of green electricity (offshore wind farms). The construction of new offshore wind will imply an increase of activity of the upstream enterprises. Similarly, downstream enterprises (e.g. transport, infrastructure manufacturers) will observe an increase of activity.

A.4. Step 4: Net indirect impact identification and definition

Net indirect impacts correspond to the propagation of impacts identified in A.2 into the value chain of the identified products, i.e. the other sources of electricity production. Indeed, as the consumption of the other sources of electricity is expected to decrease, a decrease of economic activity may be expected in the upstream and downstream enterprises.

A.5. Step 5: Summary of impacts on consumers and producers

A summary of the impact of the PAM on the consumers and producers is presented in Table 87.

			Gross direct impact	Gross indirect impact	Net direct impact	Net indirect impact
Product 1: Green electricity production (offshore wind)	Producer	Producer P1	↗EA. E		↘ EA. E	
		Upstream Prod.		↗EA. E		↘ EA. E
		Downstream Prod.		↗EA. E		↘ EA. E
	Consumer	Households	↗ Q		↘ Q	
		Industry	↗ Q		↘ Q	
		Public sector	↗ Q		↘ Q	

Table 87: Summary of impacts on producers and consumers

Legend: ↗ – Increase. ↘ – Decrease. EA – Economic Activity. E – Employment. Q – Quantity.

Impacts on public sector

The implementation of this PAM will imply some costs for the public sector, related to the economic support provided by GWh installed.

Summary of impacts considered

A summary of the socio-economic impacts considered in our evaluation to run a net direct and indirect impacts assessment is presented in Table 88.

			Gross impacts	Net impacts
Product 1: Green electricity production (offshore wind)	Producer	Producer P1	↗ EA, ↗I, ↗ E	NE
		Upstream Prod.	↗ E	NE
		Downstream Prod.	↗ E	NE
	Consumer	Households	NE	NE
		Industry	NE	NE
		Public sector	NE	NE
Public sector	Policy implementation costs		↗ AC	NA
	Tax revenue impacts		NE	NE
Externalities			NE	NE
Other macro-economic indicators			NE	NE

Table 88: Assessed impacts of the EP-A01 Offshore wind PAM on producers. consumers and the public sector

Legend: = NE – Not evaluated. N – Negligible impact. Q – impact on quantity consumed. AC - impact on administrative costs. EA – impact on economic activity. E – impact on employment. I – impact on investments. NA – Non-Applicable. ↗ – increasing impact. ↘ – decreasing impact

B. Methodology of evaluation

The methodology of evaluation of socio-economic indicators is presented in Table 89. Data sources used are detailed in Table 90.

Identified impacts		Method
Public sector		
Implementation costs	Administrative costs (€)	NIC*E_Support
Producers		
Gross direct & indirect employment (€)		$NIC*(DEC^{CONSTRUCTION}+IEC^{CONSTRUCTION})$ + $NIC^{CUMUL}*DEC^{PRODUCTION}$
Economic activity (%)		$NIC^{(n)}/IC^{(n-1)}$

Table 89: Method of estimation of the socio-economic impacts identified

Legend: NIC – New installed capacity (Gwh). E_Support – Economic support (€ per Gwh). $DEC^{CONSTRUCTION}$ – Direct employment costs during the construction phase (€/Gwh). $IEC^{CONSTRUCTION}$ – Indirect employment costs during the construction phase (€/Gwh). $DEC^{PRODUCTION}$ – Direct employment costs during the production phase (€/Gwh). NIC^{CUMUL} – Cumlative new installed capacity (Gwh). IC – Installed capacity (Gwh). $^{(n)}$ – year n. $^{(n-1)}$ – year n-1.

Identified impacts	Data	Source
Public sector > Administrative costs	E_support	Data “Norther”. L’ECHO (16/12/16)
Producers > Gross direct & indirect employment (€)	$DEC^{CONSTRUCTION}$, $IEC^{CONSTRUCTION}$ & $DEC^{PRODUCTION}$	Estimation from data “Norther”. L’ECHO (16/12/16) and STATBEL (FTE costs for industry)
Producers > Economic activity (%)	$IC^{(n-1)}$	Own estimation (see emission calculation part)
For each impact	NIC	Own estimation (see emission calculation part)

Table 90: Data sources

Legend: E_Support – Economic support (€ per Gwh). $DEC^{CONSTRUCTION}$ – Direct employment costs during the construction phase (€/Gwh). $IEC^{CONSTRUCTION}$ – Indirect employment costs during the construction phase (€/Gwh). $DEC^{PRODUCTION}$ – Direct employment costs during the production phase (€/Gwh). NIC – New installed capacity (Gwh).

C. Results

The impacts of the PAM EP-A01 "Offshore wind" are presented in Figure 44. As of 2021, socio-economic changes will manly occur because of the additional installed capacity which is expected in 2025 and 2027. The implementation costs fluctuate between 286 M€ in 2025 to 430 M€ in 2027. The costs for producers will remain of about 4 M€ from 2021 to 2024 before surging to 2330 M€ in 2025 and to 3500 M€ in 2027. The costs decrease then to nearly 8 M from 2028 till 2040. Those costs are mostly due to investment costs, translating a year-by-year increase of economic activity (of +31% in 2025 and +35% in 2027).

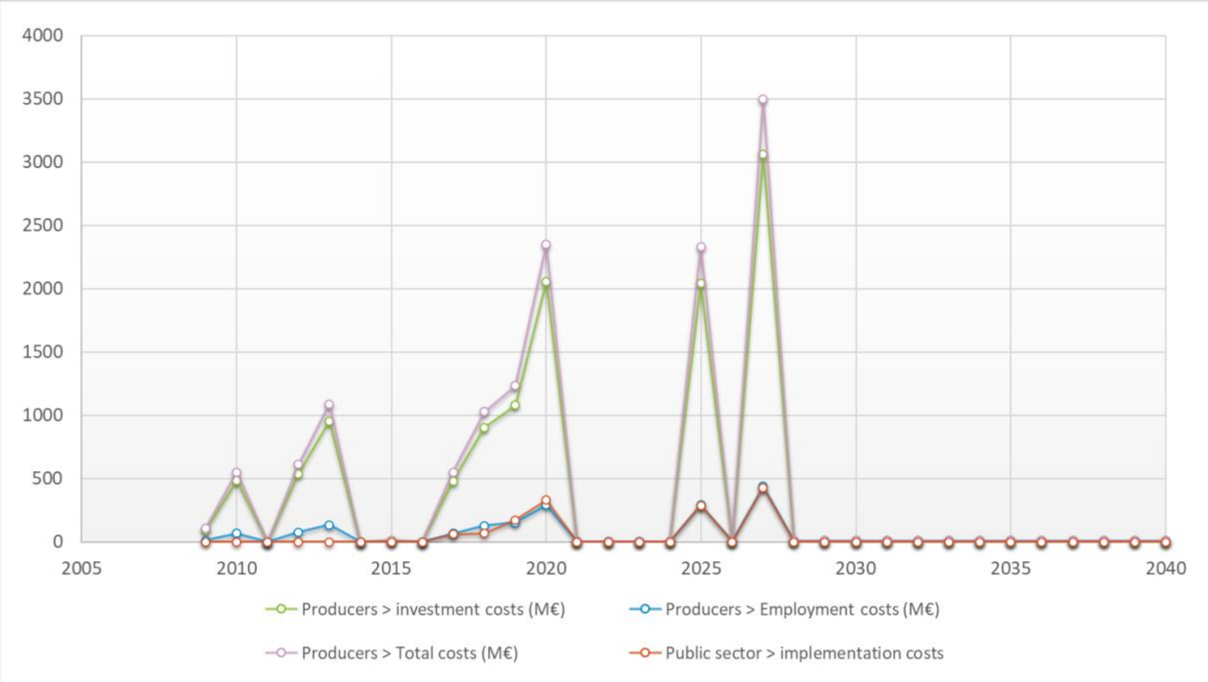


Figure 44: Socio-economic impacts of the PAM EP-A01 "Offshore wind"

4.2.4. PAM « TR-D01 – Biofuels»

Biofuel policy is based on European and Belgian legislation. Regarding the European legislations, there is the renewable energy directive 2009/28/EC (which requests biofuels in transport) that was recast in December 2018 to Renewable Energy Directive 2018/2001/EU (RED II)) and the fuel quality directive 98/70/EC (which requests a reduction of the carbon content in transport fuels). Regarding the Belgian legislation, there are notably the KB 21 July 2016 on the minimal required volumes of sustainable biofuels in gasoline (it foresees 8.5 volume % of bioethanol (5.7% energy)), the KB 20 April 2015 transposing Council Directive (EU) 2015/652 laying down calculation methods and reporting requirements pursuant to Directive 98/70/EC and the KB 26-11-2011 on biofuels, which sets environmental criteria (energy efficiency, GHG balances), agriculture criteria (use of pesticides and fertilizers), proximity criteria (shortest distance between production biomass and production unit), etc.).

A. Identification and description of the socio-economic impacts

Impacts on consumers and producers

A.1. Step 1: Gross direct impacts identification and definition

The implementation of the PAM TR-D01 is expected to increase the demand of ethanol and biodiesel. We assume an inelastic supply (Table 91).

Sub-steps	Product 1
Sub-step 1 - Identification of goods and services concerned by the PAM	Ethanol and biodiesel
Sub-step 2 - Identification of impact on supply and demand	Increase of demand
Sub-step 3 - Characterization of elasticities of supply and demand	Supply inelasticity

Table 91: Presentation of results of sub-steps 1, 2 and 3

An increase of economic activity and employment is expected given that the consumption is going to increase (Table 92). However, we assume that the gross margin will remain the same. In the same way, we assume that the purchase costs for consumers will not be impacted. Indeed, we are aware that purchase costs may vary accordingly to the new biofuel share but we have no information to quantify this potential impact.

Gross direct impacts	Ethanol and biodiesel
Impact on producers	
• Economic activity (volume of production)	↗
• Gross margin (modification of costs of production without a modification of the associated sell prices – and vice-versa)	=
• Employment	↗
Impact on consumers	
• Total quantity purchased	↗
• Purchase costs (of goods and services)	=

Table 92: Presentation of results of sub-step 4

Legend: ↗ – Increasing impact. ↘ – Decreasing impact. = – No impact.

A.2. Step 2: Net direct impact identification and definition

Net direct impacts concern potential substitution effects related to the impact on products identified in step 1, i.e. the biofuels. The products substituted are gasoline and diesel. The impacts on these fuels are similar to the gross direct impacts but in an opposite way (see Table 93).

Net direct impacts	
Impact on producers	
• Economic activity (volume of production)	↘
• Gross margin (modification of costs of production without a modification of the associated sell prices – and vice-versa)	=
• Employment	↘
Impact on consumers	
• Total quantity purchased	↘
• Purchase costs (of goods and services)	=

Table 93: Definition of net direct impacts on producers and consumers

Legend: ↗ – Increasing impact. ↘ – Decreasing impact. = – No impact.

A.3. Step 3: Gross indirect impact identification and definition

Gross indirect impacts correspond to the propagation of impacts identified in A.1 into the value chain of ethanol and biodiesel production.

A.4. Step 4: Net indirect impact identification and definition

Net indirect impacts correspond to the propagation of impacts identified in A.2 into the value chain of diesel and gasoline.

A.5. Step 5: Summary of impacts on consumers and producers

A summary of the impact of the PAM on the consumers and producers is presented in Table 94.

			Gross direct impact	Gross indirect impact	Net direct impact	Net indirect impact
Product 1: Ethanol and biodiesel	Producer	Producer P1	↗EA. E		↘ EA. E	
		Upstream Prod.		↗EA. E		↘ EA. E
		Downstream Prod.		↗EA. E		↘ EA. E
	Consumer	Households	↗ Q		↘ Q	
		Industry	↗ Q		↘ Q	
		Public sector	↗ Q		↘ Q	

Table 94: Summary of impacts on producers and consumers

Legend: ↗ – Increase. ↘ – Decrease. EA – Economic Activity. E – Employment. Q - Quantity

Impacts on public sector

Implementation costs may arise for the implementation of this PAM, related to some administrative costs. However, we have no information to quantify these costs and we assume that they are negligible in comparison with the other socio-economic indicators quantified in the next subsection.

Summary of impacts considered

A summary of the socio-economic impacts considered in our evaluation to run a net direct and indirect impacts assessment is presented in Table 95. Only one indicator is evaluated: the increase of economic activity of producers.

			Net direct and indirect impacts
Product 1: Ethanol and biodiesel	Producer	Producer P1	Evaluated (EA)
		Upstream Prod.	NE
		Downstream Prod.	NE
	Consumer	Households	NA
		Industry	NA
		Public sector	NA
Public sector	Policy implementation costs		N
	Tax revenue impacts		NE
Externalities			NE
Other macro-economic indicators			NE

Table 95: Assessed impacts of the PAM TR-D01 on producers. consumers and the public sector

Legend: EA – Economic activity. NA – Non-Applicable. ↗ – increasing impact. NE – Not Evaluated.

B. Methodology of evaluation

The increase in economic activity is evaluated through the additional costs (operational and capital costs) related to the increase of biofuel consumption (Table 96). The data used to make this evaluation is presented in Table 97.

Identified impacts		Method
Producers		
Economic activity	Capital costs	consumption*coefficient CC
	Operational impacts	consumption*coefficient OC

Table 96: Method of estimation of the socio-economic impacts identified

Legend: coefficient CC - capital costs per TJ consumed. coefficient OC - operational costs per TJ consumed

Identified impacts	Data	Source
Producers > Economic activity	Consumption of biofuels	Own estimation (see emission calculation part)
	Coefficient CC	IISD (Vito econotec)
	Coefficient OC	IISD (Vito econotec)

Table 97: Data sources

C. Results

The impacts of the PAM TR-D01 "Biofuels" on the producer costs are presented in Figure 45. These costs will reach a peak to 787 M€ in 2024 before reducing to 664 M€ in 2030 and to 650 M€ by 2040. corresponding to capital and operational costs for ethanol and biodiesel. This cost increase is due to an increase of economic activity for these products.

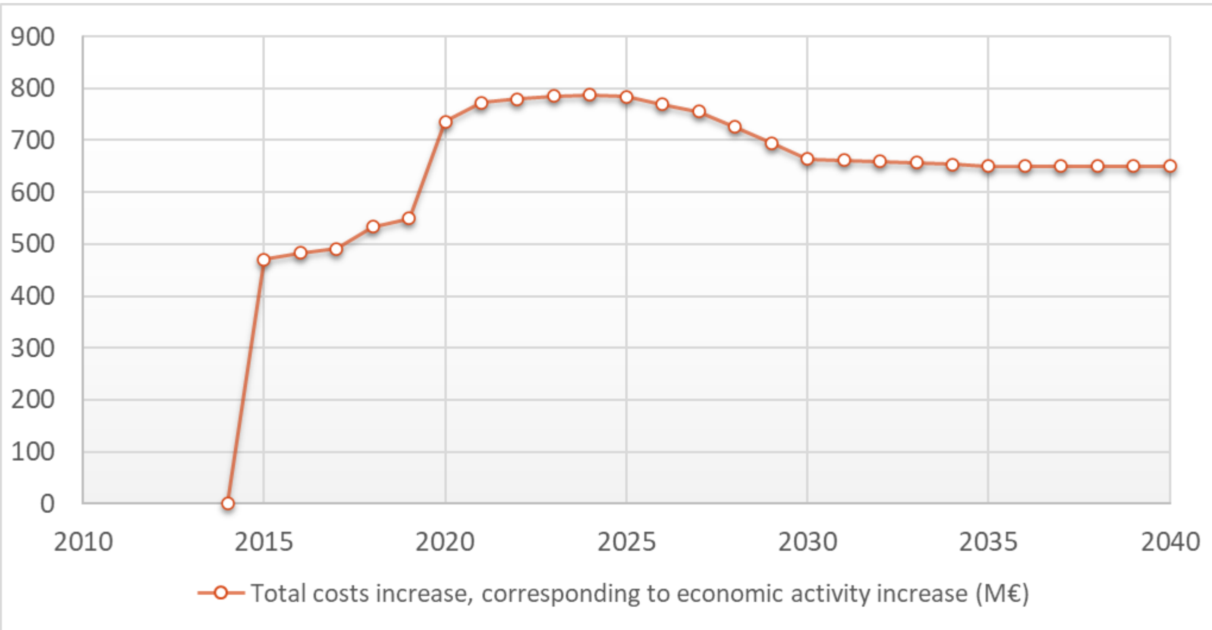


Figure 45: Impact of PAM TR-D01 « Biofuels » on the economic activity of producers of ethanol and biodiesel

4.2.5. PAM « APP-T01 – Positive Mobility allocation »

This PAMs permits proposing workers an alternative option than a company car, as a mobility budget or a net salary increase. The net salary increase will be subject to similar fiscal rules as the actual company car. The measure will be established following the principle of budget neutrality for the federal government (and the company).

In March 2018, the 'cash for car' system was put in place, to enable employees to exchange their company cars for a **mobility allowance**. Complementary to this, in March 2019, a second alternative for the company car was introduced, the ***mobility budget***.

As of the 1st of January 2021, the mobility allowance, or 'cash for car' system, is no longer in place as the law of 30 March 2018 was annulled by the Constitutional Court's ruling no. 11/2020.

Consequently, it was decided to keep the 2017 methodology and hypotheses for this PAM while updating the number of cars abandoned.

A. Identification and description of the socio-economic impacts

Impacts on consumers and producers

A.1. Step 1: Gross direct impacts identification and definition

As presented in step 1 from section PARTIE A : 4.1.2.B. the identification and definition of the gross direct impacts of a PAM may be done by a four sub-steps process. The results of the three first sub-steps are presented in Table 98. In this table, we decided first to consider the impact of the product "Fuel for consumption at own charges". Indeed, we decided not to focus on the net impact of consumption of fuel as we will not consider the impacts on producer (impact on economic activity assumed to be negligible). The only effect that is non-negligible regarding fuel consumption is the fact that more fuel will be at charge of consumers if they decide having a net salary increase (Table 99). We do not consider the impacts of reducing use of fuel consumption linked to the decrease in km driven because these costs were covered by the companies and we know that the net impact for these companies will be neutral[31].

The same justification may be done for cars: the decreasing use of company cars is not expected to significantly impact the producers and there is no impact for companies (as they offer an increase of net salary in compensation). However, the investment costs for second-hand vehicles may be important at the consumer scale (second impact considered of the PAM). Some people may nevertheless decide to use alternative mobilities. We consider there is no significant impact on producers (Table 99).

In both cases, the impact is an increase of demand at a constant price (inelastic supply).

Sub-steps	Product 1	Product 2
Sub-step 1 - Identification of goods and services concerned by the PAM	Fuel consumption at own charge of the consumer	Second-hand vehicles
Sub-step 2 - Identification of impact on supply and demand	Demand shift	Demand shift
Sub-step 3 - Characterization of elasticities of supply and demand	Inelastic supply	Inelastic

Table 98: Results of sub-steps 1, 2 & 3

[31] It has to be noted that another effect could arise: as probably the people driving a small amount of km will opt for the salary increase instead of the company car, the company will only keep the most expensive company cars (burning the most fuel). However, we have no information to quantify this potential effect.

Gross direct impacts	Fuel consumption at own charge of the consumer	Second-hand vehicles
Impact on consumers		
• Total quantity purchased	↗	↗
• Purchase costs (of goods and services)	=	=

Table 99: Results of sub-step 4

Legend: ↗ – Increasing impact. ↘ – Decreasing impact. = – No impact.

A.2. Step 2: Net direct impact identification and definition

Net direct impacts concern potential substitution effects related to the impact on products identified in step 1. There is no substitution effect.

A.3. Step 3: Gross indirect impact identification and definition

Gross indirect impacts correspond to the propagation of impacts identified in A.1 into the value chain of identified products. As mentioned in A.1, we consider these effects negligible.

A.4. Step 4: Net indirect impact identification and definition

As no substitution effect has been identified in A.2, there is no net indirect impact.

A.5. Step 5: Summary of impacts on consumers and producers

A summary of the impact of the PAM on the consumers and producers is presented in Table 100.

			Gross direct impact	Gross indirect impact	Net direct impact	Net indirect impact
Product 1: Fuel consumption	Producer	Producer P1	Negligible			
		Upstream Prod.		Negligible		
		Downstream Prod.		Negligible		
	Consumer	Households	↗ Q			
		Industry	NA			
		Public sector	NA			
Product 2 : Second-hand car	Producer	Producer P2	Negligible			
		Upstream Prod.		Negligible		
		Downstream Prod.		Negligible		
	Consumer	Households	↗ Q			
		Industry	NA			
		Public sector	NA			

Table 100: Summary of net. gross direct and indirect impact considered

Legend: Q – impact on quantity consumed. NA – Non-Applicable. ↗ – increasing impact. ↘ – decreasing impact

Impacts on public sector

Two categories of impacts are distinguished for the public sector, the policy implementation costs and the tax revenue impacts. In this case, there are no policy implementation costs as the rule for policy implementation is a neutral impact on the government budget. We will not estimate the tax revenue impact as by taking into account only the perspective of the consumer changing from company to private car, the subsequent information provided by the tax revenue indicator would not be relevant (increase of tax revenue related to fuel consumption of this category of consumers whereas there is a net decrease in fuel consumption).

Summary of impacts considered

A summary of the socio-economic impacts considered in our evaluation to run a net direct and indirect impacts assessment are presented in Table 101. Costs arising from the use of second-and cars are not evaluated because there is no information easily available to quantify this effect. Only two indicators are quantified for households: costs arising from fuel consumption and benefits arising when the option "Company car" is not chosen.

Table 101 : Assessed impacts on producers, consumers and the public sector

<table>
<tr><th colspan="3"></th><th>Net direct and indirect impacts</th></tr>
<tr><td rowspan="6">Product 1: Fuel consumption</td><td rowspan="3">Producer</td><td>Producer P1</td><td>N</td></tr>
<tr><td>Upstream Prod.</td><td>N</td></tr>
<tr><td>Downstream Prod.</td><td>N</td></tr>
<tr><td rowspan="3">Consumer</td><td>Households</td><td>Evaluated (PFC)</td></tr>
<tr><td>Industry</td><td>NA</td></tr>
<tr><td>Public sector</td><td>NA</td></tr>
<tr><td rowspan="6">Product 2: Second-hand cars</td><td rowspan="3">Producer</td><td>Producer P2</td><td>N</td></tr>
<tr><td>Upstream Prod.</td><td>N</td></tr>
<tr><td>Downstream Prod.</td><td>N</td></tr>
<tr><td rowspan="3">Consumer</td><td>Households</td><td>NE</td></tr>
<tr><td>Industry</td><td>NA</td></tr>
<tr><td>Public sector</td><td>NA</td></tr>
<tr><td rowspan="2">Public sector</td><td colspan="2">Policy implementation costs</td><td>NA</td></tr>
<tr><td colspan="2">Tax revenue impacts</td><td>NA</td></tr>
<tr><td colspan="3">Externalities</td><td>NA</td></tr>
<tr><td colspan="3">Other macro-economic indicators</td><td>Evaluated (SB)</td></tr>
</table>

Legend: N – Negligible impact. PFC – Private fuel consumption costs. SB – Salary benefits for households. NA – Non-Applicable.

B. Methodology of evaluation

The methodology of evaluation of costs and savings for consumers is presented in Table 102. Data used are detailed in Table 103.

Identified impacts	Method
Consumers costs > increase of private fuel consumption	$Km*P^{FUEL}$
Consumers savings > increase salary	Km*Salary_increase

Table 102: Methodology of evaluation

Legend: km – increasing driven km at charge of consumers. P^{FUEL} - average price of diesel and gasoline

Identified impacts	Data		Source
Consumers costs > increase of private fuel consumption	Km driven with private cars		Own estimation (TML)
	Fuel	Diesel	Own estimation (see PAM « Increase of excise duty »)
		Gasoline	Own estimation (see PAM « Increase of excise duty »)
Consumers savings > increase salary	Average value of a company cars for companies		Securex 28/01/2016 on http://www.jobat.be/fr/articles/que-sont-les-avantages-dune-voiture-de-societe/

Table 103: Data sources

C. Results

The results are presented in Figure 46. As this PAM was annulled in 2021, results remain constant beyond that year. The results show that the increase salary could compensate the costs related to the fuel consumption of private consumers in the first years of PAM implementation. However, in the 2020 a difference of approximatively 0.2 M€ is observed, i.e. it is a net cost for households to change from a company car to an increase in net salary. The fact that the gap is increasing across the years is due to the PAM increase of excise duty of diesel (and we assume here that the share between diesel and gasoline was equivalent). It should also be kept in mind that other additional costs related to the purchase and maintenance of a second-hand car (in replacement of the company cars) are not considered.

These poor results may confirm a conclusion drawn in the 2017 report which mentioned that “this change from company car to increase salary may not arise without additional subsidies to enable consumers having a second-hand car and have private travels”. Given the lack of success by consumers the PAM was not prolonged. Hence, consumers might have lacked the right incentives to embrace the alternatives offered by this PAM.

It has to be noted that the results presented concern only a part of the reality, i.e. increase in fuel consumption at charge of households while at societal level, there is a decrease in fuel consumption).

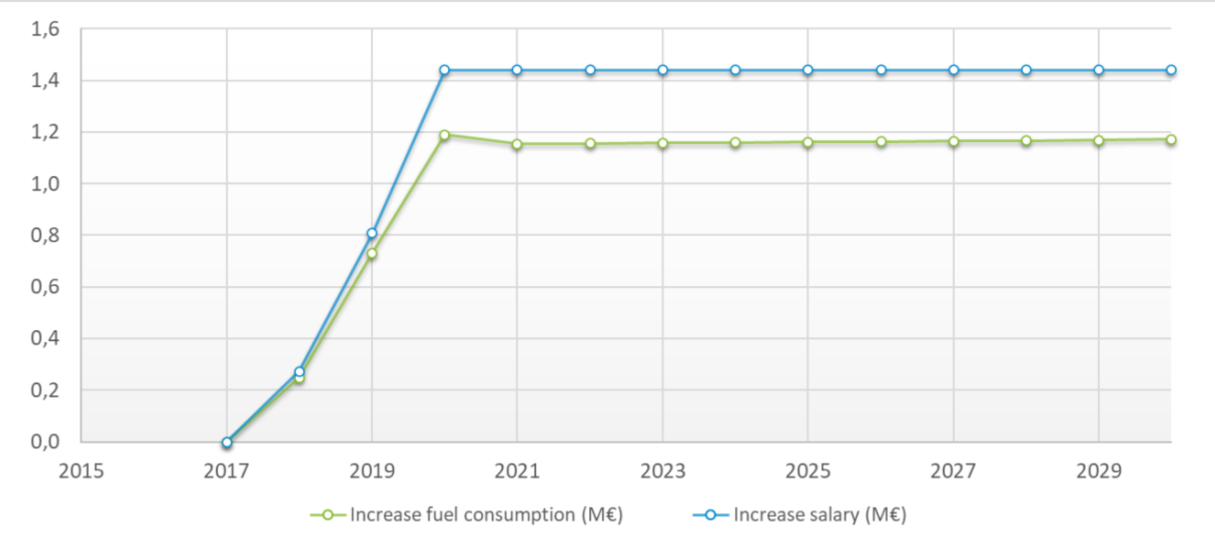


Figure 46: Impacts of Positive Mobility Allocation on consumers

4.2.6. PAM « APP-T02 – Incentives for pedelecs »

The evaluation of emissions reductions for this PAM was based on specific incentives for pedelecs:

- Speedpedelecs get fiscal deductibility of 120% for buying and 22 cent/km (indexed) for using it;
- A 15% income tax reduction for all pedelecs and speed pedelec when bought was added.

As mentioned in section 3.3.1 of this report. it was eventually decided to not implement the 15% income tax reduction. The remaining part of this PAM was therefore the per km cycling allowance for home-work traffic, which makes the measure similar the TR-A03, promoting bicycle use (except for the fiscal deductibility for speed pedelecs). Consequently. this PAM was integrated in the TR-A03 and is no longer evaluated separately. This explains why no socio-economic impact assessment was conducted for this PAM.

4.2.7. PAM « APP-T03 – Reduction of traction energy use in railways »

The NMBS/SNCB initially wanted to reduce primary energy consumption by 3 to 4% per passengerkm via different measures (2020 compared to 2015): increase train occupancy, reduce energy losses while at stop and use more efficient rolling stock. Further efforts will be made by NMBS/SNCB to reduce its traction energy consumption by 4% per passenger-km in 2022 compared to 2017.

A. Identification and description of the socio-economic impacts

Impacts on consumers and producers

A.1. Step 1: Gross direct impacts identification and definition

Three products are impacted by the PAMs. First, the goods and services that will be used by the NMBS/SNCB to reduce its energy use such as more efficient rolling stock, materials to reduce energy losses while at stop, etc. The second and third products impacted by the PAM are diesel and electricity consumptions. As opposed to the 2017 evaluation, the NMBS/SNCB did not communicate estimates on diesel consumption reduction. Consequently, we could not perform the evaluation for this product.

In all cases, we see the effect of the PAM as a demand shift: increase of demand for product 1 and decrease of demand for product 2. We assume the supply inelastic: the demand shift will not influence the prices.

Sub-steps	Product 1	Product 2
Sub-step 1 - Identification of goods and services concerned by the PAM	Energy efficient materials	Electricity
Sub-step 2 - Identification of impact on supply and demand	↗ Demand	↘ Demand
Sub-step 3- Characterization of elasticities of supply and demand	Inelastic supply	Inelastic supply

Table 104: Presentation of results of sub-steps 1, 2 and 3

The last sub-step consists in identifying and defining the impacts on producers and consumers of products identified in sub-step 1 in the conditions defined in sub-step 2 and 3. These impacts are presented in Table 105.

Gross direct impacts	Energy efficient materials	Electricity
Impact on producers		
• Economic activity (volume of production)	↗	↘
• Gross margin (modification of costs of production without a modification of the associated sell prices – and vice-versa)	=	=
• Employment	↗	↘
Impact on consumers		
• Total quantity purchased	↗	↘
• Purchase costs (of goods and services)	=	=

Table 105: Presentation of results of sub-steps 4

Legend: ↗ – Increasing impact. ↘ – Decreasing impact. = – No impact.

A.2. Step 2: Net direct impact identification and definition

Net direct impacts concern potential substitution effects related to the impact on products identified in step 1. There are no substitution effects.

A.3. Step 3: Gross indirect impact identification and definition

Gross indirect impacts correspond to the propagation of impacts identified in Step 1 into the value chain of identified products, i.e. energy efficient materials.and electricity. The economic activity (and employment) in the upstream and downstream firms are expected to increase for the products "Energy efficient materials" or decrease for the product "Electricity".

A.4. Step 4: Net indirect impact identification and definition

As no substitution effect has been identified in Step 2, there is no net indirect impact.

A.5. Step 5: Summary of impacts on consumers and producers

A summary of the impact of the PAM on the consumers and producers is presented in Table 106.

			Gross direct impact	Gross indirect impact	Net direct impact	Net indirect impact
Product 1: Energy efficient materials	Producer	Producer P1	↗EA & E		NA	
		Upstream Prod.		↗EA & E		NA
		Downstream Prod.		↗EA & E		NA
	Consumer	Households	NA		NA	
		Industry	NA		NA	
		Public sector	↗Q		NA	
Product 2: Electricity	Producer	Producer P3	↘EA & E		NA	
		Upstream Prod.		↘EA & E		NA
		Downstream Prod.		↘EA & E		NA
	Consumer	Households	NA		NA	
		Industry	NA		NA	
		Public sector	↘Q		NA	

Table 106: Summary of impacts of the PAM on producers and consumers

Legend: EA – Economic activity. E – Employment. NA – non-applicable – Q – Impact on quantity consumed. ↗ – increasing impact. ↘ – decreasing impact

Impacts on public sector

Two categories of impacts are distinguished for the public sector. the policy implementation costs and the tax revenue impacts. Regarding implementation costs, they correspond to the investments costs for the public sectors as consumers highlighted in Table 106. Regarding tax revenue, the balance between lower electricity consumption and higher consumption of energy efficient materials must be evaluated.

Summary of impacts considered

A summary of the socio-economic impacts considered in our evaluation to run a net direct and indirect impacts assessment are presented in Table 107.

We assume that the impacts on producers in terms of economic activity and employment are negligible relatively to the sector. Consequently, only two indicators are relevant: (i) the investments costs related to the higher quantity of goods and services purchased for using more energy efficient materials (public sector > NMBS/SNCB), and (ii) savings from reduction of electricity consumption (public sector > NMBS/SNCB).

However, investments costs for energy efficient materials were not evaluated since no data was available at FPS mobility. A deeper investigation at NMBS/SNCB should be necessary to make this evaluation.

It is not relevant to study tax revenue impacts given that they all concern the public sector.

			Net direct and indirect impacts
Product 1: Energy efficient materials	Producer	Producer P1	N
		Upstream Prod.	N
		Downstream Prod.	N
	Consumer	Households	NA
		Industry	NA
		Public sector	NE (IC)
Product 2 & 3: Electricity	Producer	Producer P2	N
		Upstream Prod.	N
		Downstream Prod.	N
	Consumer	Households	NA
		Industry	NA
		Public sector	Evaluated (ES)
Public sector	Policy implementation costs		NE (IC)
	Tax revenue impacts		NA
Externalities			NE
Other macro-economic indicators			NE

Table 107: Assessed impacts on producers. consumers and the public sector

Legend: NE – Not evaluated. N – Negligible impact. NA – Non-Applicable. IC – Investment costs. ES – Economic savings.

B. Methodology of evaluation

As stated before. the implementation costs are not assessable because there is no information on the means that must be implemented to reach the goal of energy consumption reduction.... The methodology of evaluation is described in Table 108 and data sources in Table 109.

Identified impacts	Method
Consumers (NMBS/SNCB)	
Fuel expenditure reduction (€)	+ EC*p_T^e

Table 108: Method of evaluation of socio-economic indicators

Legend: EC – estimated decrease of energy consumption. p_T^e – energy price (all taxes included)

Identified impacts	Data		Source
Consumers > Public sector (NMBS/SNCB) > Fuel expenditure reduction	Decrease in electricity consumption		Our evaluation (see Section “Emission reduction”)
	Energy price	Electricity	Eurostat. FPB

Table 109: Data sources

C. Results

The implementation of the PAM would permit consumers saving from to 4 M€ in 2021 to 15.5 M€ in 2025 (Figure 45).

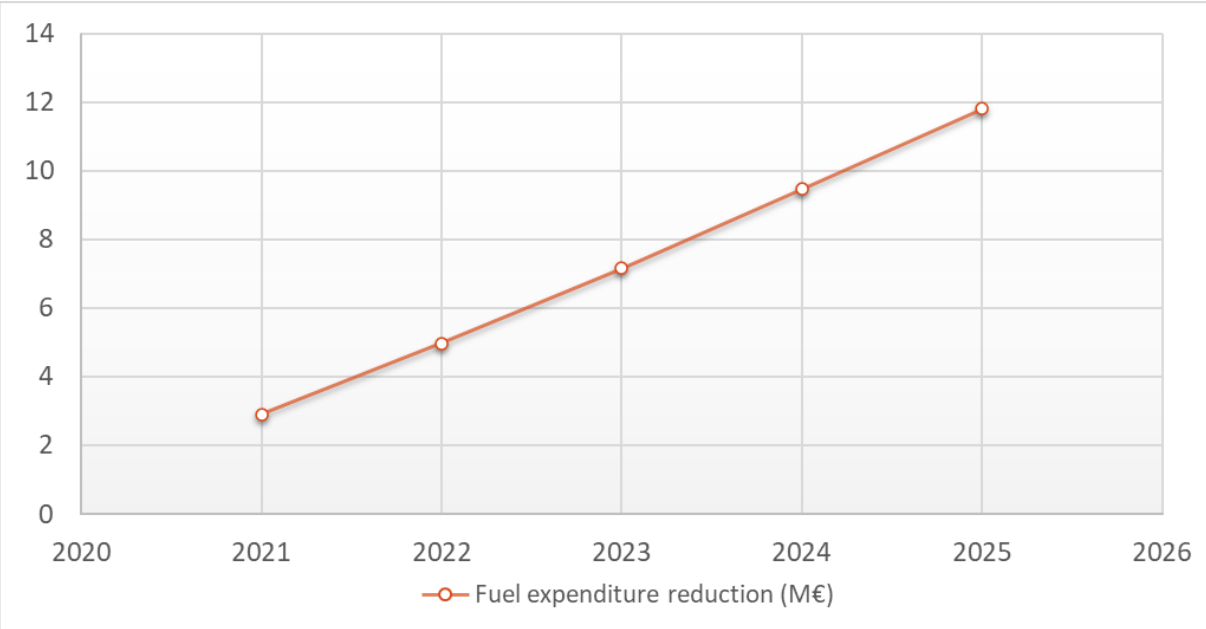


Figure 47: Impact of PAM APP-T03 "Reduction of traction energy use in railways"

4.2.8. PAM « APP-T04 – Reduction of non-traction energy use in railways »

Between 2016 and 2020, the NMBS/SNCB group has reached a 13 % reduction of energy consumption for non-traction activities. This means that the goal of seven percent of energy consumption reduction for the period 2014-2020 was reached and even surpassed by 6 %.

As for Infrabel, it has effectuated various efforts to increase the energy consumption of owned buildings and is currently constructing new buildings to move offices from rented space towards owned space. The new buildings are planned to respect current passive house standards and air temperature will be mainly regulated by heat pumps. The aim is to effectuate a fuel switch towards electricity and to stop using heating oil by 2030.

Infrabel is also shifting its carpark towards electric vehicles and is installing charging stations in owned buildings. Consequently, Infrabel's electricity consumption is expected to increase.

A. Identification and description of the socio-economic impacts

Impacts on consumers and producers

A.1. Step 1: Gross direct impacts identification and definition

Two types of products are impacted by the PAMS. First, the goods and services that will be implemented by the NMBS/SNCB to reduce its energy use:

- Renewal and modernization of lighting installation systems for railway stations. offices and other building services
- Continuation of the renewal of heating systems in buildings
- Replacement of old production facilities with more energy efficient one
- Restoration of existing buildings (isolation. etc.)

The second product impacted by the PAM is energy consumption.

In both cases, it corresponds to a demand shift: increase of demand for product 1 and decrease of demand for product 2. We assume the supply inelastic: the demand shift will not influence the prices.

Sub-steps	Product 1	Product 2
Sub-step 1 - Identification of goods and services concerned by the PAM	Renewal. Replacement. Restoration. etc.	Energy
Sub-step 2 - Identification of impact on supply and demand	Demand shift	Demand shift
Sub-step 3 - Characterization of elasticities of supply and demand	Inelastic supply	Inelastic supply

Table 110: Presentation of results of sub-steps 1, 2 and 3

The last sub-step consists in identifying and defining the impacts on producers and consumers of products identified in sub-step 1 in the conditions defined in sub-step 2 and 3 (Table 111).

Gross direct impacts	Renewal, Replacement, Restoration, etc.	Energy
Impact on producers		
• Economic activity (volume of production)	↗	↘
• Gross margin (modification of costs of production without a modification of the associated sell prices – and vice-versa)	=	=
• Employment	↗	↘
Impact on consumers		
• Total quantity purchased	↗	↘
• Purchase costs (of goods and services)	=	=

Table 111: Presentation of results of sub-steps 4

Legend: ↗ – Increasing impact. ↘ – Decreasing impact. = – No impact.

A.2. Step 2: Net direct impact identification and definition

Net direct impacts concern potential substitution effects related to the impact on products identified in step 1. There are no substitution effects.

A.3. Step 3: Gross indirect impact identification and definition

Gross indirect impacts correspond to the propagation of impacts identified in Step 1 into the value chain of identified products, i.e. products for renewal, restoration, etc. and energy. The economic activity (and employment) in the upstream and downstream firms are expected to increase or decrease respectively.

A.4. Step 4: Net indirect impact identification and definition

As no substitution effect has been identified in Step 2, there is no net indirect impact.

A.5. Step 5: Summary of impacts on consumers and producers

A summary of the impact of the PAM on the consumers and producers is presented in Table 112.

			Gross direct impact	Gross indirect impact	Net direct impact	Net indirect impact
Product 1: Renewal. Restoration. etc.	Producer	Producer P1	↗ EA & E		NA	
		Upstream Prod.		↗ EA & E		NA
		Downstream Prod.		↗ EA & E		NA
	Consumer	Households	NA		NA	
		Industry	NA		NA	
		Public sector	↗Q		NA	
Product 2: Energy	Producer	Producer P2	↘EA & E		NA	
		Upstream Prod.		↘EA & E		NA
		Downstream Prod.		↘EA & E		NA
	Consumer	Households	NA		NA	
		Industry	NA		NA	
		Public sector	↘Q		NA	

Table 112: Summary of impacts of the PAM on producers and consumers

Legend: EA – Economic activity. E – Employment. NA – non-applicable – Q – Impact on quantity consumed. ↗ – increasing impact. ↘ – decreasing impact

Impacts on public sector

Two categories of impacts are distinguished for the public sector, the policy implementation costs and the tax revenue impacts. Regarding implementation costs, they correspond to the investments costs for the public sectors as consumers highlighted in Table 112. Regarding tax revenue, the balance between lower energy consumption and higher consumption of restoration works has to be evaluated.

Summary of impacts considered

A summary of the socio-economic impacts considered in our evaluation to run a net direct and indirect impacts assessment is presented in Table 113.

We assume that the impacts on producers in terms of economic activity and employment are negligible relatively to the sector. It is not relevant to study tax revenue impacts on the public sector because impacts concern only the public sector (NMBS/SNCB). Therefore, only two indicators are relevant: (i) the investments costs related to the higher quantity of goods and services purchased for renewal, restoration etc.. and (ii) savings from reduction of energy consumption. However, the investments costs, i.e. the implementation costs, are not assessable because there is no information on the means that should be implemented to reach the goal of energy consumption reduction.

			Net direct and indirect impacts
Product 1: Renewal, Restoration, etc.	Producer	Producer P1	N
		Upstream Prod.	N
		Downstream Prod.	N
	Consumer	Households	NA
		Industry	NA
		Public sector	NE
Product 2 : Energy	Producer	Producer P2	N
		Upstream Prod.	N
		Downstream Prod.	N
	Consumer	Households	NA
		Industry	NA
		Public sector	Evaluated (ES)
Public sector	Policy implementation costs		NE
	Tax revenue impacts		NA
Externalities			NA
Other macro-economic indicators			NA

Table 113: Assessed impacts on producers. consumers and the public sector

Legend: N – Negligible impact. NA – Non-Applicable. NE – Not Evaluated. ES – Energy savings.

B. Methodology of evaluation

As a reduction in energy consumption has been quantified in the section "Emission reductions", it is possible to assess the savings made by the public sector. The methodology of evaluation is described in Table 114 and data sources in Table 115.

Identified impacts	Method
Consumers	
Public sector (€)	+ EC*p_T^e

Table 114: Method of evaluation of socio-economic indicators

Legend: EC – estimated decrease of energy consumption. p_T^e – energy price (all taxes included)

Identified impacts	Data		Source
Public sector > Consumers	Energy consumption		Our evaluation (see Section "Emission reduction")
	Energy price	Natural gas	Eurostat. FPB
		Heating oil	Eurostat. FPB
		Electricity	Eurostat. FPB

Table 115: Data sources

It must be noted that data provided by the NMBS/SNCB stops in 2025. This means that the 2026-2030 period displayed below only covers data from Infrabel. To avoid discrepancies in results, we opted for displaying cumulative results instead of yearly results as usually done.

C. Results

The implementation of the PAM would permit saving up to 10 M€ in 15 years (2015 to 2030) for NMBS/SNCB and Infrabel combined due to savings made from a lower energy consumption (Figure 48).

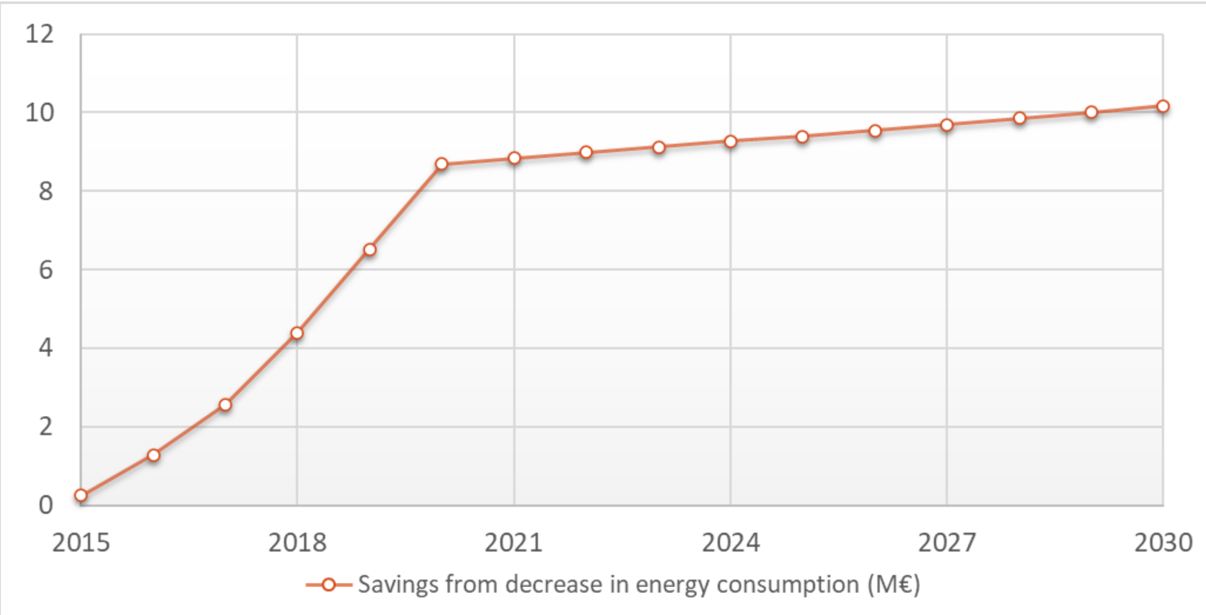


Figure 48: Impact of PAM APP-T04 "Reduction of non-traction energy use in railways"

4.2.9. PAM « XX-X04 – Increase of excise duty on diesel »

The PAM is motivated by the implementation of the "Royal Decree of 26 October 2015", published on 30th October 2015. and the law of 27 June 2016. Through this law, the special excise duty for diesel in passenger cars (non-commercial use) is increased from 2015 to 2018. The law also establishes the aim of achieving an equal rate of excise duty for diesel and gasoline, which was confirmed by Jean-Baptiste Traversa (MINFIN) for the 2021 update of this PAM. The primary objective of this PAM is to improve air quality.

A. Identification and description of the socio-economic impacts

Impacts on consumers and producers

A.1. Step 1: Gross direct impacts identification and definition

The implementation of an increase of excise duty on diesel will impact four categories of products: diesel, gasoline, diesel cars and gasoline cars. With regards to diesel and gasoline, the impact on the market can be seen as a demand shift: decrease of demand for diesel (shift to the left) because of the increasing tax and an increase of demand for gasoline (shift to the right) because of the decreasing tax. In both cases, we assume that the supply is inelastic, i.e. the supply shift will not affect the gross margin of producer (tax incidence on producer). With regards to the diesel and gasoline cars, the impact on the market can be traduced as a demand shift: a decrease in diesel cars purchase and an increase in gasoline cars purchase. Again. in both cases we assume an inelastic supply: the demand shift will not affect cars prices.

Sub-steps	Product 1	Product 2	Product 3	Product 4
Sub-step 1 - Identification of goods and services concerned by the PAM	Diesel	Gasoline	Diesel cars	Gasoline cars
Sub-step 2 - Identification of impact on supply and demand	Demand shift	Demand shift	Demand shift	Demand shift
Sub-step 3 - Characterization of elasticities of supply and demand	Supply inelasticity	Supply inelasticity	Supply inelasticity	Supply inelasticity

Table 116: Presentation of results of sub-steps 1, 2 and 3

The decrease and increase in fuel consumptions/cars purchases are expected to impact the economic activity of the **producers**. Employments will be affected proportionally. Given the supply inelasticity, we expect no impact on gross margin (Table 117).

Regarding the **consumers**, higher costs may arise from the increase in the price of diesel. However, as the total consumption is decreasing in favour of gasoline consumption (whose purchase price is decreasing), the total effect is not known. Regarding cars purchases, no variation in price is expected but as the evolution of the fleet is impacted by the PAM, we may assess the variation in purchase costs for consumers (decreasing for diesel cars and increasing for gasoline cars). It has to be noted that we assume that their purchasing behaviour is not impacted by the PAM. In other words, the consumers will not buy new vehicles if theirs are not amortized.

Gross direct impacts	Diesel	Gasoline	Diesel cars	Gasoline cars
Impact on producers				
• Economic activity (volume of production)	↘	↗	↘	↗
• Gross margin (modification of costs of production without a modification of the associated sell prices – and vice-versa)	=	=	=	=
• Employment	↘	↗	↘	↗
Impact on consumers				

• Total quantity purchased	↘	↗	↘	↗
• Purchase costs (of goods and services)	↗	↘	=	=

Table 117: Presentation of results of sub-steps 4

Legend: ↗ – Increasing impact. ↘ – Decreasing impact. = – No impact.

A.2. Step 2: Net direct impact identification and definition

Net direct impacts concern potential substitution effects related to the impact on products identified in step 1, i.e. diesel, gasoline and associated cars. For each product, there might be a substitution effects with similar products as other fuels (biofuels, natural gas, electricity) and associated types of cars (hybrid cars, electric cars, etc.). However, as this substitution impact was identified to be very low, we consider that these net direct impacts are negligible.

A.3. Step 3: Gross indirect impact identification and definition

Gross indirect impacts correspond to the propagation of impacts identified in A.1 into the value chain of identified products, i.e. diesel, gasoline and associated cars. As in all cases an impact is expected on the economic activity, this impact will be transferred proportionally to the upstream and downstream value chain.

A.4. Step 4: Net indirect impact identification and definition

As net direct impacts were identified to be negligible, the net indirect impacts may also be considered negligible.

A.5. Step 5: Summary of impacts on consumers and producers

A summary of the impact of the PAM on the consumers and producers is presented in Table 118.

			Gross direct impact	Gross indirect impact	Net direct impact	Net indirect impact
Product 1: Gasoline	Producer	Producer P1	↗ EA. ↗ E		Negligible	
		Upstream Prod.		↗ EA. ↗ E		Negligible
		Downstream Prod.		↗ EA. ↗ E		Negligible
	Consumer	Households	↗Q		Negligible	
		Industry	↗Q		Negligible	
		Public sector	↗Q		Negligible	
Product 2: Diesel	Producer	Producer P2	↘EA. ↘E		Negligible	
		Upstream Prod.		↘EA. ↘E		Negligible
		Downstream Prod.		↘EA. ↘E		Negligible
	Consumer	Households	↘Q		Negligible	
		Industry	↘Q		Negligible	
		Public sector	↘Q		Negligible	
Product 3: Diesel cars	Producer	Producer P3	↘EA. ↘E		Negligible	
		Upstream Prod.		↘EA. ↘E		Negligible
		Downstream Prod.		↘EA. ↘E		Negligible
	Consumer	Households	↘Q		Negligible	
		Industry	↘Q		Negligible	
		Public sector	↘Q		Negligible	
Product 4: Gasoline cars	Producer	Producer P4	↗ EA. ↗ E		Negligible	
		Upstream Prod.		↗ EA. ↗ E		Negligible
		Downstream Prod.		↗ EA. ↗ E		Negligible
	Consumer	Households	↗Q		Negligible	
		Industry	↗Q		Negligible	
		Public sector	↗Q		Negligible	

Table 118: Summary of impacts on producers and consumers

Legend: ↗ – Increase. ↘ – Decrease. EA – Economic Activity. E – Employment. Q – Quantity.

Impacts on public sector

Two categories of impacts are distinguished for the public sector, the policy implementation costs and the tax revenue impacts. Regarding the policy implementation costs, we consider the impact negligible as the PAM implementation only necessitates updates of the tax level. The tax-revenue will be modified due to the evolution of the excise duties on diesel and gasoline but also to the evolution of the fuel consumption.

Externalities

The primary objective of this PAM is to improve air quality. We assessed this positive externality and its monetary implications by focusing on the estimation of two elements impacting air quality: NOx and $PM_{2.5}$[32].

Summary of impacts considered

A summary of the socio-economic impacts considered in our evaluation to run a net direct and indirect impacts assessment are presented in Table 119. It must be noted that impacts on producers were not evaluated as producers both produce gasoline and diesel cars: we assume the net impact will be negligible. Regarding consumers, we assumed the impacts negligible for non-household's consumers.

			Net direct and indirect impacts
Product 1: Gasoline	Producer	Producer P1	NE
		Upstream Prod.	NE
		Downstream Prod.	NE
	Consumer	Households	Evaluated (PC)
		Industry	N
		Public sector	N
Product 2: Diesel	Producer	Producer P2	NE
		Upstream Prod.	NE
		Downstream Prod.	NE
	Consumer	Households	Evaluated (PC)
		Industry	N
		Public sector	N
Product 3: Diesel cars	Producer	Producer P2	NE
		Upstream Prod.	NE
		Downstream Prod.	NE
	Consumer	Households	Evaluated (PC)
		Industry	N
		Public sector	N
Product 4: Gasoline cars	Producer	Producer P2	NE
		Upstream Prod.	NE
		Downstream Prod.	NE
	Consumer	Households	Evaluated (PC)

[32] PM2.5 = particulate matter, fine particles with diameters lower or equal to 2.5 micrometers.

		Industry	N
		Public sector	N
Public sector	Policy implementation costs		N
	Tax revenue impacts		Evaluated
Externality costs			Evaluated
Other macro-economic indicators			NE

Table 119: Assessed impacts of the Ecodesign Regulation on producers. consumers and the public sector

Legend: NE – Not Evaluated. N – Negligible impact. PC – impact on purchase costs.

B. Methodology of evaluation

The impact of the PAM in terms of fuel consumption and prices were already estimated in the emission calculation part of the report. The impact of the PAM on the public sector and the consumers may be calculated from these estimations. As mentioned in the emissions section, data were estimated by 2030 and kept constant until 2040.

First, we compared the consumer expenditures in the business-as-usual and in the PAM scenario (Table 120). Second, we evaluated the change in the tax revenue for the public sector as described in Table 120. Investments costs related to change of fleet and externality costs related to the impacts on air quality are also estimated. Regarding investments costs, it has to be noted that the calculation is very approximate because we don't have a stock model (investment costs may be lower).

Identified impacts	Method
Consumers (€) > Reduction fuel consumption	$[(p^{T\text{-}DIES\text{--}BAU} * C^{DIES\text{-}BAU}) + (p^{T\text{-}GAS\text{--}BAU} * C^{GAS\text{-}BAU})]$ $- [(p^{T\text{-}DIES\text{-}PAM} * C^{DIES\text{-}PAM}) + (p^{T\text{-}GAS\text{--}PAM} * C^{GAS\text{-}PAM})]$ If >0. then it is a saving for the consumers
Public sector (€) > Tax revenue impact	$[(p^{ed\text{-}DIES\text{-}PAM} * C^{DIES\text{-}PAM}) + (p^{ed\text{-}GAS\text{--}PAM} * C^{GAS\text{-}PAM})]$ $- [(p^{ed\text{-}DIES\text{--}BAU} * C^{DIES\text{-}BAU}) + (p^{ed\text{-}GAS\text{--}BAU} * C^{GAS\text{-}BAU})]$ If <0. then it is a cost for the public sector
Consumers (€) > Investments costs change due to fleet variation	$(EvF^{DIES}) * p^{DIES\text{-}CAR}$ $+(EvF^{GAS}) * p^{GAS\text{-}CAR}$ If >0. then it is a saving for the consumers
Externality	$TC * (EF^{NOX} * MV^{NOX} + EF^{PM25} * MV^{PM25})$

Table 120: Method of estimation of the socio-economic impacts identified

Legend: p^T – total price. P^{ed} – excise duty price. DIES – diesel. GAS – gasoline. BAU – Business as usual. PAM – Scenario with PAM implementation. EvF – Evolution of Fleet. TC – Total reduction in fuel consumption. EF – Emission factor. MV – Monetary value. C – Consumption.

C. Results

An increase in excise duty for diesel will imply savings for consumers: up to 628.6 M€ by 2025 and 730.4 M€ by 2030 for fuel consumptions and up to 122.6 M€ by 2025 and 101.7 by 2030 for car purchases (Figure 49). Economic savings are also expected due to positive externalities arising from PAM implementation (increase in air quality): up to 110.5 M€ by 2025 and 211.3 M€ by 2030. Regarding the public sector, the decrease in tax will imply a decrease in tax revenue up to 513.6 M€ by 2025 and 584.6 M€ by 2030. However, again, savings made by consumers may imply induced purchased that may counterbalances this decrease in tax revenues. The year-by-year impacts are presented in Table 121.

Year	Consumers' savings - M€		Public sector (M€)	Externality (M€)
	Consumers > Savings Fuel consumption (M€)	Consumers > Savings Car investments (M€)	Tax revenue	Externality Savings (M€)
2015	0.0	0.0	0.0	0.0
2016	0.0	0.0	0.0	0.0
2017	0.0	0.0	0.0	0.0
2018	-120.5	-8.1	102.5	-2.0
2019	-31.2	-22.2	25.9	-3.6
2020	-64.2	0.6	54.0	-3.7
2021	535.3	166.9	-449.5	27.2
2022	557.8	137.1	-464.8	47.2
2023	582.3	132.3	-481.8	68.3
2024	605.9	125.5	-498.0	89.5
2025	628.6	122.6	-513.6	110.5
2026	650.5	121.7	-528.7	131.5
2027	671.8	120.1	-543.5	152.2
2028	692.0	107.2	-557.6	172.5
2029	711.6	87.5	-571.3	192.3
2030	730.4	101.7	-584.6	211.3
2031	730.4	101.7	-584.6	211.3
2032	730.4	101.7	-584.6	211.3
2033	730.4	101.7	-584.6	211.3
2034	730.4	101.7	-584.6	211.3
2035	730.4	101.7	-584.6	211.3
2036	730.4	101.7	-584.6	211.3
2037	730.4	101.7	-584.6	211.3
2038	730.4	101.7	-584.6	211.3
2039	730.4	101.7	-584.6	211.3
2040	730.4	101.7	-584.6	211.3

Table 121: Socio-economic impacts on consumers and the public sector (net present values)

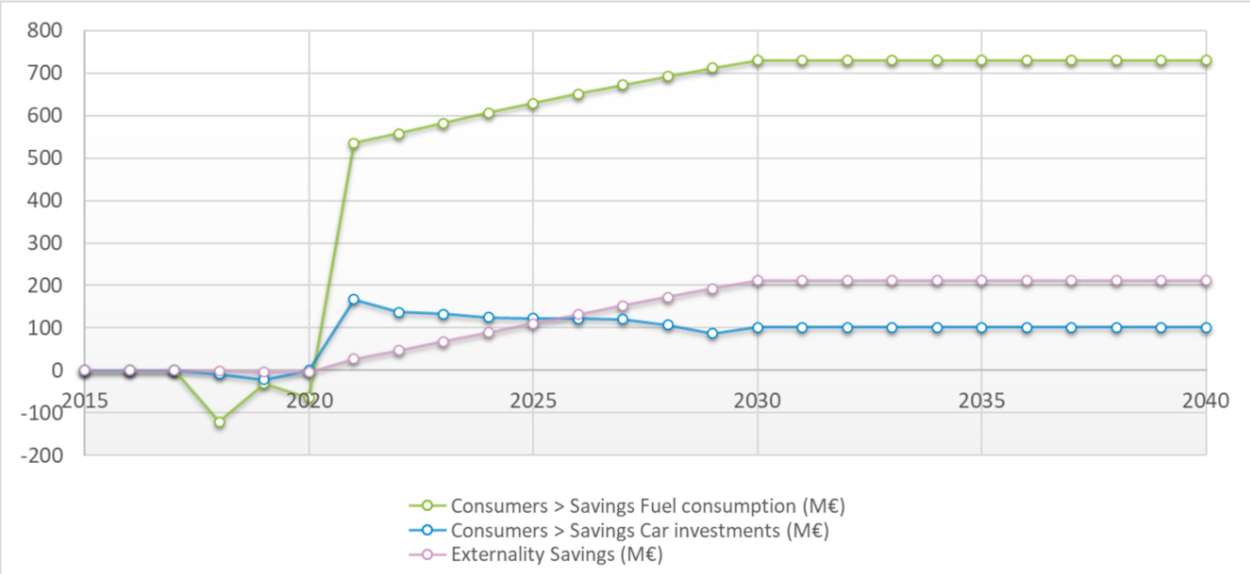


Figure 49: Savings for households and society related to the implementation of the PAM (M€)

5. Appendix

5.1. Comparison of emissions reductions estimates following "average" electricity emission factor

The methodology used to compute the marginal electricity production emission factor is described in section 3.1. An alternative method could have been used, which is the average electricity production emission factor (EF).

The average EF ambitions to reflect the CO_2 emissions generated from electricity produced by natural gas power plants in comparison to the total amount of electricity produced all production means combined. It is thus derived from the following equation:

$$EF_A = \frac{E_{NG} * \mathrm{EF}_M}{E_T}$$

With :

- EF_A = Average electricity production emission factor
- EF_M = Marginal electricity production emission factor
- E_{NG} = Quantity of electricity produced by natural gas power plants
- E_T = Total quantity of electricity produced

The table below compares the emission factors according to the two methods:

Year	Electricity EF (kgCO2eq/kWh)	
	Marginal method	Average method
2004	0.38	0.27
2005	0.38	0.28
2006	0.38	0.25
2007	0.38	0.24
2008	0.38	0.24
2009	0.38	0.21
2010	0.38	0.21
2011	0.38	0.19
2012	0.38	0.21
2013	0.38	0.19
2014	0.38	0.21
2015	0.38	0.23
2016	0.38	0.17
2017	0.38	0.18
2018	0.38	0.21
2019	0.38	0.17
2020	0.38	0.17
2021	0.38	0.17
2022	0.38	0.18
2023	0.37	0.18
2024	0.36	0.19
2025	0.36	0.19

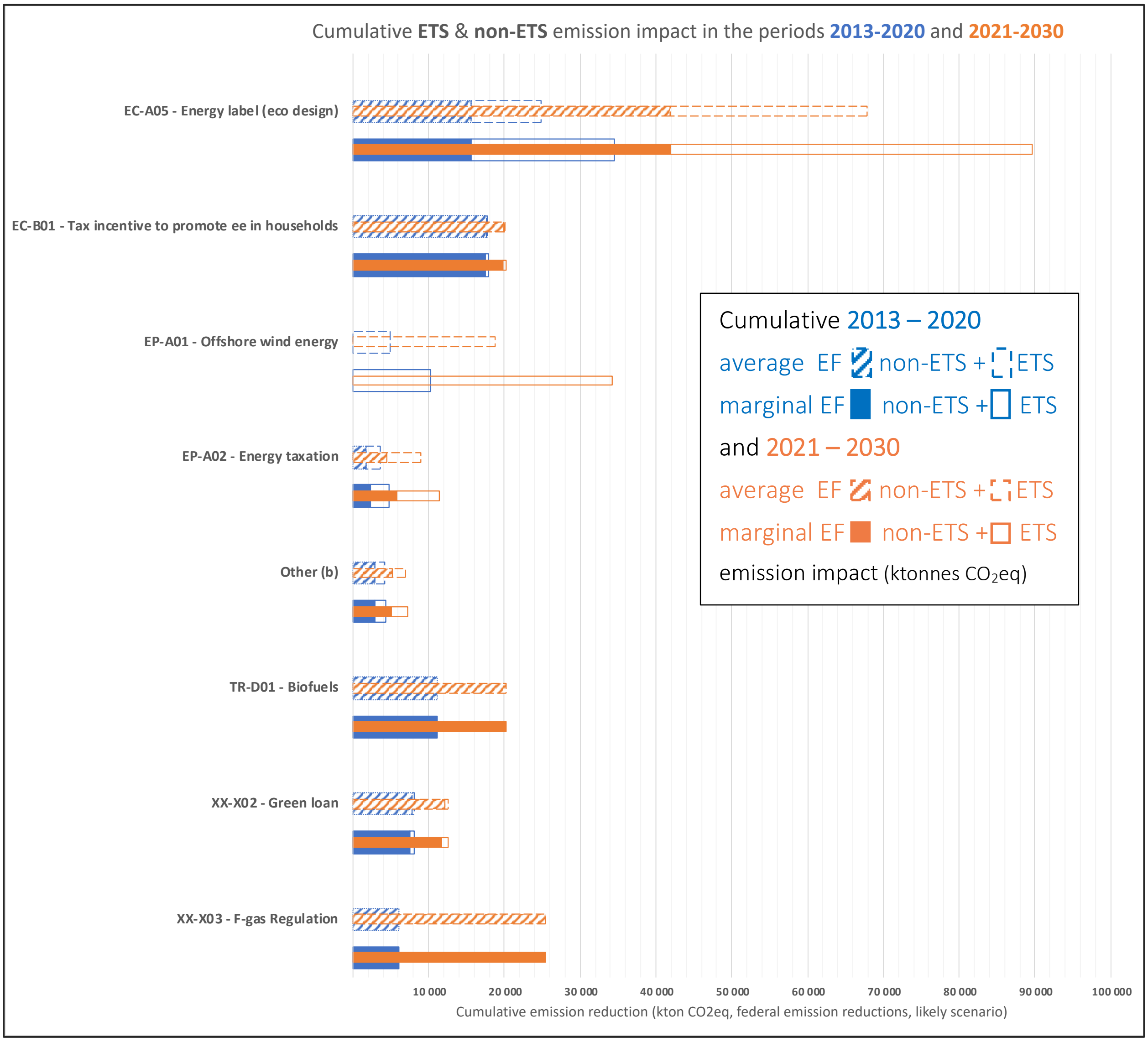
2026	0.35	0.19
2027	0.35	0.20
2028	0.35	0.20
2029	0.35	0.21
2030	0.35	0.21
2031	0.35	0.21
2032	0.35	0.21
2033	0.35	0.21
2034	0.35	0.20
2035	0.35	0.20
2036	0.35	0.20
2037	0.35	0.20
2038	0.35	0.20
2039	0.35	0.20
2040	0.34	0.19
2041	0.34	0.19
2042	0.34	0.19
2043	0.34	0.19
2044	0.34	0.19
2045	0.34	0.19
2046	0.34	0.18
2047	0.34	0.18
2048	0.34	0.18
2049	0.34	0.18
2050	0.34	0.18

Following the changes in electricity production emission factor, the table below displays cumulative ETS & non-ETS emission reductions in the periods 2013-2020 and 2021-2030 for both the marginal and average method:

PAM code	PAM titre	Marginal approach						Average approach					
		2013 - 2020		2021 - 2030		2031 - 2050		2013 - 2020		2021 - 2030		2031 - 2050	
		Federal		Federal		Federal		Federal		Federal		Federal	
		ETS	Non-ETS	ETS	Non-ETS	ETS	Non-ETS	ETS	Non-ETS	ETS	Non-ETS	ETS	Non-ETS
APP-T01	Positive mobility allocation	-	3	-	5	-	-	-	3	-	5	-	-
APP-T03	Rail traction	15	16	271	64	325	81	7	16	146	64	185	81
APP-T04	Rail non traction	24	16	58	64	122	150	11	16	26	64	55	150
EC-A05	Energy label (eco design)	18 886	15 650	47 673	41 919	109 426	109 117	9 206	15 650	25 877	41 919	61 872	109 117
EC-B01	Tax incentive to promote ee in households	340	17 548	425	19 762	176	7 385	183	17 645	228	19 882	93	7 430
EC-B03	FRGE	0.7	132	0.9	182	0.5	127	0.4	133	0.5	183	0.3	127
EP-A01EP-A05	Offshore wind energy	10 229	-	34 283	-	85 005	-	4 964	-	18 768	-	48 027	-
EP-A02	Energy taxation	903	-	1 079	-	2 159	-	903	-	1 079	-	2 159	-
IP-A06	Tax deduction for energy savings	2 392	2 392	5 732	5 732	13 134	13 134	1 798	1 798	4 497	4 497	10 493	10 493
OB-A03	EMAS	-	6	-	7	-	14	-	5	-	6	-	12
OB-B01	Renewable energy fedesco and belgian railways	121	-	349	-	800	-	54	-	156	-	359	-
OB-B02	Energy efficiency fedesco	126	309	190	509	427	304	126	309	190	509	427	304
OB-C02	Free public transport federal civil servants	-	5	-	4	-	5	-	5	-	4	-	5
OB-C04	Teleworking	-	8	-	19	-	29	-	7	-	14	-	22
OB-C07	Energy efficient cars for federal public services	-	0	-	2	-	3	-	0	-	2	-	3
TR-XXX	Advantage in kind depending on CO2 emissions for company cars	-	561	-	990	-	334	-	561	-	990	-	334

TR-A02	Promotion of public transport	-	271	-	461	-	776	-	290	-	517	-	879
TR-A03	Promoting bicylce use and pedelecs	-	13	-	57	-	111	-	13	-	57	-	111
TR-A04	Promoting multimodal systems for goods	-	100	-	6	-	-	-	100	-	6	-	-
TR-A08	Free public transport for commuters	-	67	-	97	-	163	-	71	-	109	-	185
TR-B01	Promoting carpooling	-	20	-	23	-	39	-	20	-	23	-	39
TR-B05	Eco-driving	-	174	-	-	-	-	-	174	-	-	-	-
TR-C01	Tax deduction clean cars	-	348	-	-	-	-	-	348	-	-	-	-
TR-D01	Biofuels	-	11 181	-	20 162	-	34 484	-	11 181	-	20 162	-	34 484
XX-X01	Ecocheque	170	897	173	2 309	344	8 576	170	897	173	2 309	344	8 576
XX-X02	Green loan	510	7 562	812	11 781	467	7 492	273	7 793	430	12 087	244	7 647
XX-X03	F Gases	-	6 058	-	25 431	-	72 851	-	6 058	-	25 431	-	72 851
XX-X04	Tax Shift	-	-22	-	293	-	124	-	-22	-	293	-	124

The figure below displays the cumulative non-ETS & ETS impact for the periods 2013-2020 and 2021-2030 when using a marginal versus an average emission factor, for the 7 most important PAMs + remaining PAMs ("Other"):



5.2. Appendix on Literature research on modal shift from car to train

FPS Mobility and the NMBS/SNCB could not provide any data neither to determine the number of people who used the car before switching to the train thanks to measures mentioned above. We asked for data on the origin of the NMBS/SNCB passengers, on the most frequent travel journey, on the most frequent travel destinations, etc.

In the sections below we describe the relevant literature on this topic. We investigated the literature, but even there, is not much information is available.

In general, literature states that the substitution between train (and public transport in general) is very limited. We inspire ourselves on Dutch reports (see sources) that based themselves on an extensive literature research. Two conclusions come out:

- Making railway use more attractive increases railway use
- New train users are only marginally car users, as train (or PT in general) and car are bad substitutes

5.2.1. Making railway use more attractive increases railway use

- The Dutch railways:

Between 2000 and 2012. the Dutch rail pkm increased by 19%. This was due to: population increase (+5%). economic growth (+2%), use of student card (financially interesting) (+4%), changes in fuel price (+3%), punctuality (+2%), higher frequency (+4%), increase of train tariff (-6%), unexplained (+5%). (Mobiliteitsbalans, 2013)

Interesting to observe is that increasing congestion had no impact on pkm by train which is different from what literature states.

The important question here is, how did those new train users made their journeys before using the train. In other words, did train use increase thanks to a model shift away from car?

- The federal diagnostic home-work transport

The 2014 federal diagnostic home work transport shows that companies providing public transport for free have significantly more people using public transport, nearly 25% instead of only 10%. But, once again, we don't know

  - how these people would have made their journey in the absence of free public transport
  - whether the external factors of the company providing public transport for free induce more public transport use from their own. Ex: Brussels companies could do more to encourage their people to come by public transport.

5.2.2. But new train users are only marginally car users as Train (or PT in general) and car are bad substitutes

- Journey time of PT generally compares badly compared to car journeys. On average PT journey time is 3 times longer than car journey time in the Netherlands, except for longer distances PT, and for short distances with departure close to station the ratio between both is better.
- In the past there was no relation in the Netherlands between congestion and rail growth.
- Lots of latent car drivers use PT during peak, however, when there is a slight reduction in congestion, those well switch back to car with reduced congestion. It is strange to see that literature states the link between congestion and higher train use, while in the past this link was not observed in the Netherlands.
- The impact of higher speed or extension of PT on substitution is limited

- 90% of car drivers don't consider using the train within the next 5 years, car users don't like to switch, except for longer distances or departures close to a station (see first bullet).

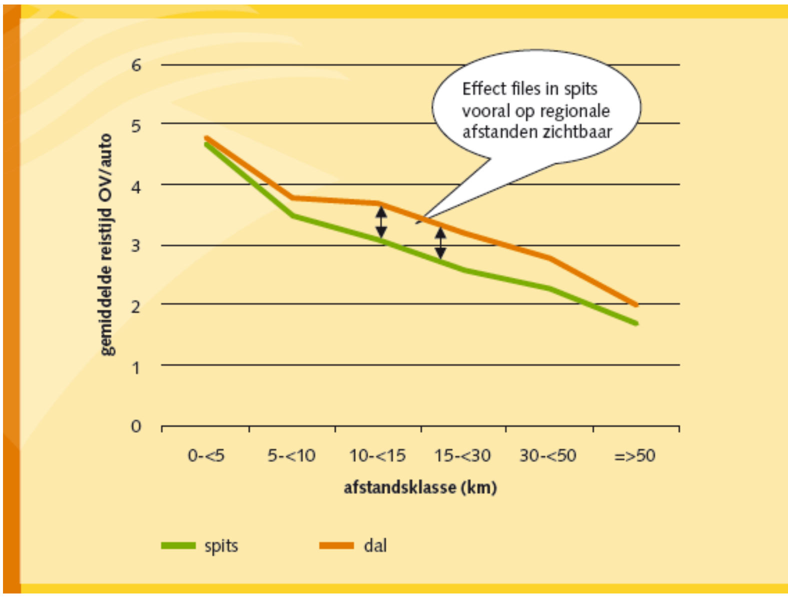


Figure 50: Ratio of public transport journey time and car journey time depending on travel distance (Savelberg, 2015)

As the graph illustrates, the journey time ratio is on average unfavourable for public transport on distances shorter than 30km (32). From a ratio journey time for PT /journey time for car of 1.5, PT gets competitive. Where the ratio is 2 today, improvements can reduce the ratio probably to 1.5. With the resources foreseen for this study we were not able to find data on this ratio for the Belgian situation, nor do we know how the policy measures have influenced this ratio.

Furthermore, people assess the waiting time and the before and after transport very negatively. The subjective waiting time and last and first mile time is perceived as twice the real-world time (33). If travelling to the station takes 5 minutes, it is perceived as 10 minutes. It is difficult to change this. It is however possible to decrease the travel time to the station by using a bicycle (or a car).

Providing better cycling conditions and facilities is however not the silver bullet. The European BiTiBi project about the promotion of bike train bike combination states that 10% (in some cases 20%) of people using the bicycle to reach the railway station would use the car for the whole train journey if the bike-train combination would not be available (BiTiBi, 2017).

Except from the last paragraph. the above section is based on Savelberg (2015).

5.2.3. Economic theory confirms low substitution.

Economic theory uses cross price elasticities. Cross price elasticizes are a classic way to see how changes in the price of one mode influence the use of the other mode. Price must be seen as general price, containing a financial component and a time component. A cross price elasticity of 0.1 of car use with respect to the train price for example means that if the price of the train decreases by 10%, car use will decrease by 1%.

The figures below illustrate some cross price elasticities from car and train. We observe from cross price elasticities below that a change in car driver conditions will influence train use, but that a change in train conditions will not, or only marginally influence car use. So, there is nearly no shift from car to train with an improvement in rail conditions. However, there is a shift from car to train if the car conditions deteriorate.

A 1% increase in car travel time leads to a 1.2% increase in train km in the short run and 0.4% in the long run. The figures below illustrate this. We remark that cross price elasticities need to be applied to “competing” traffic links. The KIM study mentions Koncept-elasticiteitenhandboek DVK 1990, gebaseerd op LMS1995 as source.

Remark however that in real world, from the passenger increase at NS in the past 0% could be attributed to increasing congestion (see above).

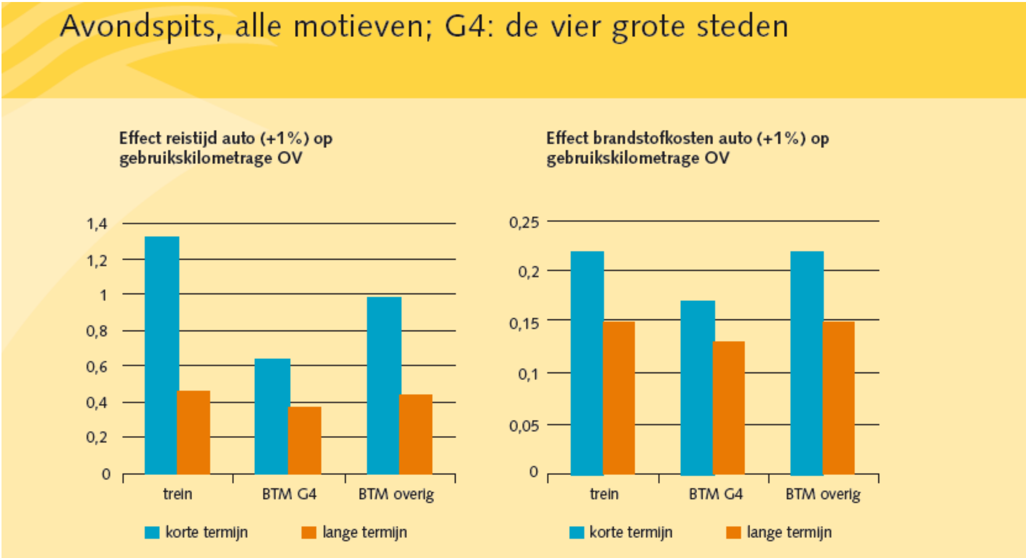


Figure 51: cross price elasticity between car and train in evening peak with a deterioration of car driving conditions (Savelberg, 2015 based on Koncept-elasticiteitenhandboek DVK 1990, gebaseerd op LMS1995)

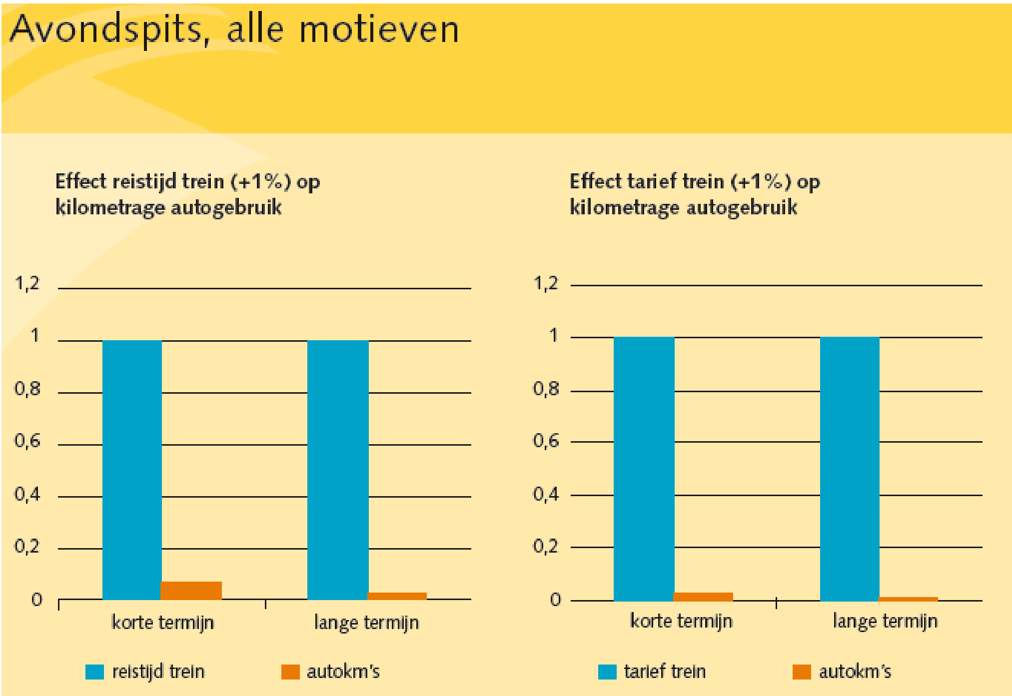


Figure 52: cross price elasticity between car and train in evening peak with a deterioration of train conditions improvement (Savelberg, 2015 based on Koncept-elasticiteitenhandboek DVK 1990, gebaseerd op LMS1995)

Litman (Litman, 2004) comes up with figures for cross price elasticities that are more favourable for public transport. This is however for PT in cities (transit systems). In the long term a 1% reduction in cost could lead to a 0.15 to 0.3% increase in transit travel. For the Belgian trains, the cross-price elasticity could be at the lower end and probably even below as the rail and car are not as good substitutes as car and public transport in a city. The table below provides elasticities for urban public transport. The last line provides cross price elasticities for car compared to urban public transport.

	Market Segment	*Short Term*	*Long Term*
Transit ridership WRT transit fares	Overall	−0.2 to −0.5	−0.6 to −0.9
Transit ridership WRT transit fares	Peak	−0.15 to −0.3	−0.4 to −0.6
Transit ridership WRT transit fares	Off-peak	−0.3 to −0.6	−0.8 to −1.0
Transit ridership WRT transit fares	Suburban commuters	−0.3 to −0.6	−0.8 to −1.0
Transit ridership WRT transit service	Overall	0.50 to 0.7	0.7 to 1.1
Transit ridership WRT auto operating costs	Overall	0.05 to 0.15	0.2 to 0.4
Automobile travel WRT transit costs	Overall	0.03 to 0.1	0.15 to 0.3

Note: WRT = With Respect To

Table 122: Elasticities for urban public transport (Litman, 2004)

To illustrate the difficulty of getting modal shift between rail and car, we mention the effect of the simulated road charging system in the Netherlands. Trainpkm would only increase by around 3%, while carpkm decrease by 10%. Remind that the absolute differences are even much more important and that half of the carkm simply disappear, this means are not replaced by another mode (Savelberg, 2015).

5.2.4. Documented real world experiences are scarce but confirm low substitution (Savelberg 2015. Diagnostic 2015. Bakker 2015)

- Flevospoorlijn Amsterdam-Almere: up to 20 minutes journey time gain, 10% of car drivers switched to train, but 25% of former bus passenger switched to car (longer first and last mile for rail compared to previous bus network and there is extra space on the road). In the end, the PT share didn't change.
- Opening of Zuidtak Amsterdam: journey time gains of up to 30 minutes, but only 3% of those passengers were previous car drivers, 95% were PT users on before.
- The evaluation of some big Dutch rail projects in the 90s didn't show any impact on car use.
- The very low tariff policy of De Lijn in the years 2000 had no significant impact on car use in Flanders.
- The evolution in the transport modes for commuting in the federal diagnostic of home-work traffic in large companies (+100 employees) gives an indication that more train users doesn't mean less cars on the road:
  - In Flanders, the diagnostic observed a status quo in car use, but an increase in train use of 36%. The number of carpoolers was drastically reduced.
  - In Wallonia, train use was up 13%, and car use increased also by 2%. The absolute increase in car users is even greater than the increase in train users. We also had a decrease in car poolers.
  - The only region where car use is reduced is Brussels, but taking into account the evolution in Flanders and Wallonia, we assume that the reason is rather the external environment that is more car hostile than the NMBS/SNCB policy. We also observe a dramatic decrease in carpoolers.

This does not provide however scientific evidence as we don't know what would have happened without the NMBS/SNCB policy.

	BELGIQUE			BRUXELLES			FLANDRE			WALLONIE		
Mode	2005	2014		2005	2014		2005	2014		2005	2014	
Voiture (seul)	66,8%	65,6%	- 2%	45,1%	37,9%	- 16%	68,7%	68,5%	- 0%	80,4%	81,7%	+ 2%
Covoiturage	4,7%	2,9%	- 38%	2,5%	1,2%	- 49%	5,2%	3,3%	- 36%	5,2%	3,4%	- 35%
Moto	1,7%	1,2%	- 33%	0,8%	1,1%	+ 38%	2,2%	1,3%	- 41%	1,5%	1,0%	- 31%
Train	9,5%	10,9%	+ 15%	32,2%	34,1%	+ 6%	4,1%	5,3%	+ 31%	4,4%	5,0%	+ 13%
Métro, tram, bus	5,9%	6,9%	+ 16%	15,0%	19,0%	+ 27%	3,9%	3,9%	+ 0%	3,6%	4,0%	+ 9%
TCE	1,2%	0,8%	- 34%	0,7%	0,3%	- 59%	1,6%	1,1%	- 31%	0,5%	0,4%	- 8%
Vélo	7,8%	9,5%	+ 21%	1,2%	3,0%	+ 148%	12,3%	14,9%	+ 21%	1,3%	1,5%	+ 13%
Marche	2,4%	2,4%	- 2%	2,6%	3,4%	+ 33%	2,1%	1,7%	- 19%	3,2%	3,1%	- 2%

Table 123: evolution in modal shares for commuting in Belgian large companies (diagnostic federal, 2015)

- When observing the NMBS data, we see stagnation in the absolute railpkm over the last 4 years with available data (2011-2014), while the number of commuters travelling for free is increasing heavily. This could indicate that deteriorating car travel conditions are a better incentive for people to travel by train than the improved offer as commuters travel in the peak while car travel conditions are worse. However, this is far from a scientific conclusion and needs much more investigation.

- Examples from abroad show modest share of ex-car users among important metro and light rail developments. These developments and improvements are significantly more important than what happened in the Belgian railways. They take also place in cities, places where conditions to drive a car are worse. On average, in the abroad examples, 11% of improved PT are car users, with peaks up to 25% (Bakker, 2015).

5.2.5. Under what circumstances is modal shift feasible?

The above section showed that modal shift from car to rail is difficult to obtain. Literature provides some conditions under which modal shift from car to rail are more likely:

- high parking tariffs and/or difficulties to find parking
- if substantial changes take place in ratios of journey times between car and public transport and if this ratio is around 1.5 or lower
- And often as a consequence, when market shares of car and PT are close to one another on links.

5.2.6. Conclusions of the literature research on modal shift from car to rail:

We conclude following based on the literature research:

- While improving train and PT performances, the number of train and PT passengers will increase.
- There will however be only a little part of those new passengers that were previously car drivers. The older literature research from Litman is less pessimistic, especially in the long term, more attractive public transport could attract extra passengers.
- There is nearly no evidence from real world experience, that by improving train and PT supply a modal shift from car to rail or PT takes place, except in cases with a significant improvement, much more significant than what was done in Belgium. Available evidence suggests that an attraction of 20 to 30% of car drivers among new train and PT users is a huge success (Savelberg. 2015). Car drivers for whom journey times of PT or not more than 1.5 the car journey time have most change for shifting to train.
- A cross price elasticity between train and car between 0 and 0.1 is probably realistic. This means that by a 10% price decrease of train, 1% of car users on a similar link will switch to train. Litman provides values for cross price elasticity of up to 0.3 for transit (between 0.1 and 0.3 in the long run and only 0.05 in the short run).
- There is some evidence that 10% of people using bicycle parking are former car users for the whole train journey (BiTiBi, 2017).
- The most effective way to reduce car use is to make it less attractive, by decreasing parking possibilities and make the PT journey time competitive with car, Litman adds that car drivers are generally responsive to service quality and higher automobile costs.

Remark:

The Walloon region counts each extra pkm from public transport as a reduction of one carpkm. They furthermore don't consider any rebound effect. We didn't find any evidence for this assumption in the literature research.

Price elasticities are calculated for a certain range of the demand curve, in other words, for price changes of 10% to 20%. This means that conclusions on big price changes (like free transport) should always be looked at very cautiously.

5.2.7. Sources

- Bakker, Peter, Han van der Loop, and Fons Savelberg. "Uitwisseling gebruikersgroepen 'auto-ov.'" Kennisinstituut voor Mobiliteitsbeleid, October 2015. https://www.kimnet.nl/binaries/kimnet/documenten/rapporten/2015/11/5/uitwisseling-gebruikersgroepen-%E2%80%98auto-ov%E2%80%99/uitwisseling-gebruikersgroepen-auto-ov-oktober.pdf.
- Litman, Todd. "Transit Price Elasticities and Cross - Elasticities." *Journal of Public Transportation* 7, no. 2 (June 1, 2004). https://doi.org/10.5038/2375-0901.7.2.3.
- KiM. "Mobiliteitsbalans 2013." Den Haag: Kennisinstituut voor Mobiliteitsbeleid, October 2013. https://www.kimnet.nl/binaries/kimnet/documenten/rapporten/2013/10/29/mobiliteitsbalans-2013/mobiliteitsbalans-2013.pdf, p. 41

- Savelberg, Fons. *Het scheiden van de markt: vraagontwikkeling in het personen- en goederenvervoer*. Den Haag: Kennisinstituut voor Mobiliteitsbeleid, 2009. https://www.kimnet.nl/publicaties/rapporten/2009/03/27/het-scheiden-van-de-markt-vraagontwikkelingen-in-het-personen--en-goederenvervoer.
- BiTiBi : Van Zeebroeck, Bruno. "BiTiBi: The Final Report," March 2017. https://bitibi.eu/dox/BitiBi_Final%20Report_2017.pdf.
- Pauwels, Christophe, and Peter Andries. "Diagnostic Des Déplacements Domicile - Lieu de Travail 2014." Bruxelles: Service public fédéral Mobilité et Transports, Direction générale Politique de Mobilité durable et ferroviaire, Direction Mobilité, January 2016. https://mobilit.belgium.be/sites/default/files/final_report_fr_5.0.pdf.

Institut de Conseil et d'Etudes en Développement Durable asbl

Boulevard Frère Orban 4
B-5000 NAMUR
00 32 81 25 04 80
www.icedd.be
icedd@icedd.be

N° registre de commerce : sans objet
N° TVA : BE0407.573.214
Représenté par : Gauthier Keutgen. Secrétaire Général
N° de compte bancaire : BE59 5230 4208 3426 / BIC TRIOBEBB