Study commissioned by the Federal Public Service of Public Health, Food Chain Safety and Environment on behalf of the National Climate Commission

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REGULAR EVALUATION OF THE REDUCTION OF EMISSIONS RESULTING FROM POLICIES AND MEASURES TAKEN BY THE FEDERAL GOVERNMENT AND CONTINUATION OF THE METHODOLOGICAL DEVELOPMENT NECESSARY FOR THIS EVALUATION.

Draft Updated Report

30 September 2011

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NOTE

This draft report is an updated version of the final report 2011. No methodological changes have been made, changes are solely due to new available information or changes in assumptions on projections (*e.g.* offshore wind energy). Not all measures have been updated at this moment, due to a lack of additional information since May 2011. To differentiate between the two, **measures that have been updated and modified are indicated with ** both in the subtitles and in the overview table (section 5)**.

CONTENTS

TABLES

FIGURES

1 INTRODUCTION

The current study is an extension of a study carried out in 2009 on the same subject[1]. It consists in:

- updating the existing evaluations (in particular by taking into account more recent statistical data);
- extending it to new measures or changes in existing measures;
- extending the time horizon from 2008-2012 to 2008-2020;
- making appropriate improvements of the methodology.

The legal basis for the obligation to evaluate the federal policies and measures (PAMs) is the cooperation agreement of 14/11/2002 between the Federal State, The Flemish Region, the Walloon Region and the Brussels Capital Region, in which it is stated that a National Climate Plan (NCP) has to be drawn up, executed, evaluated and reported to the UNFCCC under the Kyoto protocol.

Article 13 also states that the Federal State and each Region commit themselves to report annually in a harmonized way to the National Climate Commission (NCC) on the progress and implementation of PAMs that are included in the National Climate Plan and that fall under their authority.

Through the “Burden sharing agreement” of 8 March 2004 between the Federal government and the Regions, the Federal government has committed itself to take a series of complementary emission reduction measures for at least 4,8 million tonnes eq-CO_2 per year over the period 2008-2012. No additional agreement has been defined for the period 2013-2020.

This project will help the Federal government with the evaluation of the federal PAMs by providing as final result:

1. a table with, for each federal PAM, avoided CO_2-eq emissions for each year in the period 2008-2020, with a minimum and a maximum scenario, as required by Art3.2.(b) of decision 280/2004/CE;
2. for each PAM, a description, of the hypotheses in the calculation of the avoided emissions and the way of carrying out the evaluation.

This report discusses the methodology and the assumptions, focusing on the main changes and additions that have been performed in comparison with the previous study. It also provides the updated results for the period 2008-2012 and an extension of the projections until 2020.

Terminology

Three concepts of "measure" can be distinguished:

- national measure;
- federal measure;
- regional measure.

Each measure of the National Climate Plan, which is identified by a code such as EP-A02 or EC-B03, is actually a mix of one or more federal and/or regional measure(s). We call this mix a national measure. In this study, we are only interested in the national measures comprising a federal measure. Such a national measure is composed of either one federal measure or one federal measure and one or more regional measure(s).

In this report we will refer to federal measures by the code of the corresponding national measure.

When regional measures are associated with a federal measure in a same national measure, these measures are said to be linked.

In the previous study[1], the federal measures of the National Climate Plan had been screened. In total, 42 federal policy measures had been identified, analyzed and evaluated. In the present report, the descriptions of the measures are those prepared in the previous study.

Since then, the situation has only slightly changed. The following new PAMs have been identified:

- the "green loans" (reduction of the interest rate on loans for energy saving investments by households);
- introduction of fiscal deduction for wall and floor insulation (exercise 2009 and 2010), this can be considered as an addition to existing PAM EC-B01;
- the eco-cheque;
- introduction of tax deduction for the electric vehicle (exercise 2011 – 2012); this can be considered as an addition to existing PAM TR-C01.

Besides, some changes to existing measures have been taken into account:

- TR-D01 (Promotion of biofuels): Law of 22 July 2009, requiring that 4% by volume of biofuels be mixed to gasoline and diesel transport fuels;
- EC-B02 (Standards for wood stoves and coal heating systems) and AG-D04 (Quality standard for solid biofuels): Royal Decree of 12 October 2010.

1.1 Starting date of the measures

The PAMs working group of the National Climate Commission has decided that the starting date for the implementation of PAMs should be 2004[1]. We are therefore taking this year into consideration. This is in line with the fact that for monitoring the progress towards achieving the commitment made in the burden sharing agreement of March 2004, only measures from year 2004 are to be taken into account. In practice, this decision only affects a few PAMs, as most PAMs started after 2003.

2 METHODOLOGY

The impact of a policy measure in terms of emission reduction is defined as the difference between the actual emissions and the emissions that would have taken place had the measure not been implemented (generally called "baseline"), as is illustrated in Figure 1.

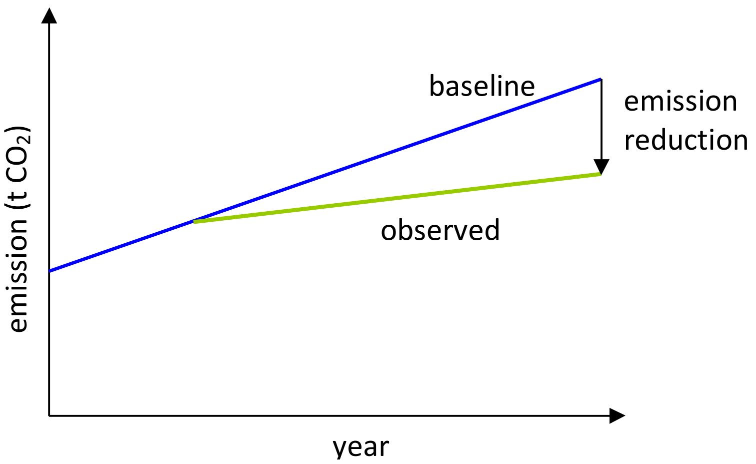

Figure 1. Emission reductions are based on observed and baseline emissions but can often be assessed directly.

A difficulty in evaluating this emission reduction arises from the fact that in general the baseline cannot be measured precisely, but can only be estimated on the basis of assumptions. Note that this type of uncertainty is also true for the impact of economic policies on employment or GDP. In this study, we therefore have adopted methodologies to determine the difference between actual and baseline emissions directly.

The Federal government has taken many policies and measures that have a positive effect on greenhouse gas emission reductions. These differ substantially from one another in several characteristics, but there are some general characteristics that need to be considered in calculating the effect on emission reductions.

[1] Procès-verbal de la réunion du GT PAMs du 9 septembre 2010.

2.1 Link with EU directive 2006/32/EC

Given the strong link between CO_2 emission reductions and energy savings, it is generally deemed desirable, whether at EU level, at federal level or at the level of the Regions, to harmonise as much as possible the methodologies used for calculating CO_2 emission reductions and energy savings.

As far as energy savings are concerned, a harmonised calculation methodology has been prepared at European level in the framework of directive 2006/32/EC[2]. This concerns both 'Top-Down' (*i.e.* aggregated by sector or by energy use) and 'Bottom-Up' (*i.e.* individually by policy measure) types of analyses. However, bottom-up calculation formulas are currently only proposed for policy measures in the buildings sector (residential and commercial).

The EU Member States are responsible for further developing and applying this methodology, which implies data collection and assumptions. To this end the Federal government and the Regions are collaborating in the framework of the CONCERE/ENOVER group in order to harmonise their approaches and assumptions. In practice, this means that there is a strong case for using whenever possible the bottom-up calculation formulas defined at EU level, at least for the calculation of energy savings. Therefore, whenever an EC bottom-up formula is available for a particular measure, we will apply it, as long as the related data are available. In practice, this is the case of the building energy savings (where typically EC-B01 measure applies). When there is no EC formula available, we have looked for alternative formulas that are harmonised with the work done within CONCERE/ENOVER.

2.2 Relationship between PAM and technical measure

For a number of PAMs, the impact can best be estimated by evaluating the penetration of a particular "technical measure" (*e.g.* roof insulation, condensing boiler). This is in particular the case when a bottom-up formula of the European Commission can be applied for calculating energy savings. In practice, the EC formulas indeed all relate to technical measures. Hence this practice is in line with the methodology for measuring energy savings in the framework of European directive 2006/32/EC.

If several PAMs support the same technical measure, we attribute the entire saving to one of these PAMs, the most representative one, which we call the "Reference PAM" for this set of PAMs[3]. No savings are then attributed to the other PAMs of the set, in order to avoid double counting. There may be some exceptions, however, *e.g.* in the case of a "sub-PAM" corresponding to the application of a PAM only to the public sector, to which we will come back later.

[2] European Commission: Recommendations on measurement and verification methods in the framework of directive 2006/32/EC on energy end-use efficiency and energy services – Preliminary Draft Excerpt, July 2010.
[3] However, whenever relevant, the contribution of regional PAMs is subtracted (see section 2.5).

2.3 Evaluation Categories

In practice, it is not possible to evaluate the emission reduction individually for all the PAMs. We have defined 8 evaluation categories and assigned one of these categories to each of the PAMs (see section 4.1).

Table 1. Evaluation categories.

N°	*Evaluation Category*	*Impact evaluation*	*Comment*
1	EC formula	X	Reference to the EU formula (case of emission reduction linked to energy savings).
2	Alternative formula	X	Specific formula used for evaluation.
3	Impact included under other measures	-	This policy is global and its impact is covered by a set of other policies, not individually referred to.
4	Order of magnitude estimated	X	No precise data for evaluation of the policy. A global quantification will be performed, for example based on global budget.
5	Negligible	-	The impact is considered as negligible and not easily quantifiable.
6	Not relevant	-	The measure has not been implemented or the impact is not significant.
7	Not quantifiable	-	No data allowing the evaluation of the policy, although the impact of the measure could be potentially significant.
8	Impact included under a single other measure	-	This policy impact is included in that of another PAM which is evaluated. The reference to this specific policy measure is mentioned.

These evaluation categories are shown in Table 1. The first two are quantitative evaluation categories. The first one corresponds to the case where the emission reduction stems from energy savings and these savings can be calculated using one of the EC formulas. The second one represents the cases where an alternative formula can be found (for example for PAMs applied outside the buildings sector).

Category 3 represents the measures of which the impact is included in that of a set of other measures of which the impact is being evaluated. These measures therefore need not be evaluated separately to get the overall policy impact. Examples of such measures are general information campaigns, which can influence the penetration of a range of technologies.

Category 8 is similar to category 3, but represents the case where the impact of a PAM is included under that of one or two well identified PAMs. In this case the relevant PAMs are identified. Category 5 and 7 are also similar but the impact of category 5 is small, whereas the impact of measures in evaluation category 7 could potentially be significant, but both are not quantifiable.

When no formula can be found for evaluating the emission reduction, it might still be possible to estimate an order of magnitude of the emission reduction, on the basis of available data such as the allocated budget. Such measures are assigned category 4. An order of magnitude can be quite useful, for example if it shows that a particular measure only has a negligible impact, or, on the contrary, if it draws attention to a measure with potentially large savings, in which case it might be recommended to improve the monitoring data.

When an evaluation is not relevant, for example because the measure has not been implemented or there is no domestic impact, the measure is assigned to category 6.

2.4 Cumulative vs. non-cumulative measures

When the impact of a PAM stems from an investment in a particular technology, the annual emission reduction generated by that investment is allocated from the time of the investment over the whole lifetime of the technology. This is the approach used in the EC methodology mentioned above for energy savings. Such “cumulative PAMs” often include investments in renewable energy (*e.g.* offshore wind energy) and investments increasing energy efficiency (*e.g.* in buildings, cars, …).

“Non-cumulative PAMs”, on the other hand, are those for which the emission reduction does not arise because of an investment. They include mostly changes in behaviour, induced or not by a financial incentive. An example is lower prices for promoting an increased use of public transport. These emission reductions only take place at that specific moment.

For cumulative reduction measures, two types of emission reductions are being calculated per year:

- *ANRED* is the *annual emission reduction* linked to the investments of the year;
- *RED* is the *total emission reduction*, equal to the annual emission reduction cumulated over the lifetime of the measure.

The CO_2 savings are calculated by year for the investments of the year (*ANRED*). The impact of this investment on the subsequent years is taken into account considering the life of the implemented technical measure (for example: if the insulation installed in year ‘n’ allows a reduction of ‘x’ CO_2 per year, the reduction ‘x’ is taken into account for each year from year ‘n’ up to year ‘n+30’, because the life of insulation technique = 30 years).

2.5 Interaction between federal and regional PAMs

The evaluation of the impact of an individual measure must take into account that other measures can contribute to a same effect. This can be the case of other federal measures or regional measures. These other measures are modifying the baseline mentioned in the introduction of chapter 2.

An example of a set of overlapping measures is the following:

- TR-A03: Promotion of bicycle use
    - fiscal deduction of the allowance paid by employers
    - lump sum fiscal deduction of the expenses for home-work transport other than with a car
- OB-C03: Promotion of bicycle use in the public sector
    - fee per km awarded to civil servants going to work by bike
- TR-A02: Improvement and promotion of public transport
    - includes objectives for bicycle parking places in the management contract of the SNCB group of companies.

A second example is the following :

- EC-B01: fiscal reduction for energy saving investments by citizens (condensing boilers, heat pumps, roof insulation, solar panels…);
- regional subsidies for energy saving investments (for similar types of equipments).

There are potentially 2 types of overlaps (Figure 2). In the first, the emission reductions of a certain PAM are completely included within the emission reductions from another PAM. In the second, only a portion of the total emission reductions of two different PAMs are overlapping.

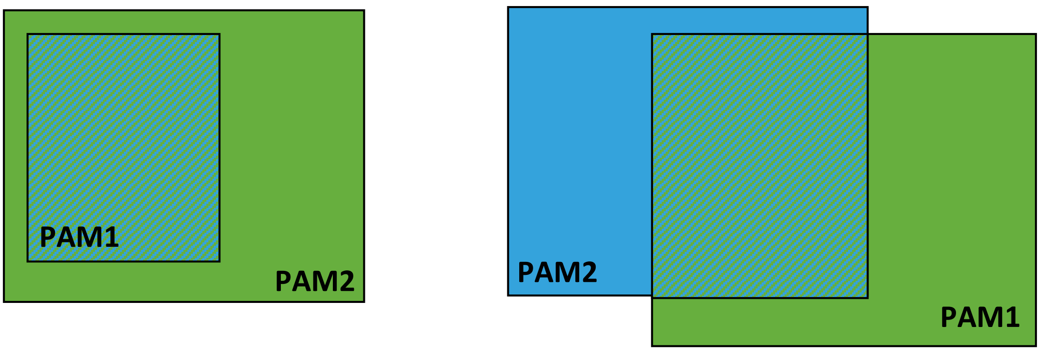

Figure 2. Illustration of two types of overlap of PAMs.

In some cases where the penetration of a technical measure can be explained by the action of more than one PAM, one or more of these may be regional PAMs. In such cases the relative contributions of the federal PAM(s) and the regional PAM(s) should be determined in one way or another, so that the contribution of the federal PAM(s) can be determined. This is the subject of the section 2.5.1.

2.5.1 Allocation of impact between federal and regional PAMs

As far as possible, the allocation of an impact between federal and regional measures is based on quantitative data. The relative impacts are assumed to be proportional to the size of the financial support of the federal and regional measures[4].

Two cases are considered:

- In the case of financial incentives such as fiscal deduction, fiscal reduction and subsidies, the emission reductions are allocated proportionately to the relative amounts of money (amount of fiscal reduction, subsidies) spent by the federal or the regional governments for the corresponding measure. For example, if the federal measure constitutes a tax reduction of 40 € and the regional measure a grant of 10 €, 80% of the emission reduction is allocated to the federal PAM and 20% to the regional PAM.
- In the case of fuel taxes for electricity production and the green certificates scheme, the impact is allocated proportionately to the relative size of the impact of these measures have on the cost of electricity production.

The allocation of impact between federal and regional PAMs is a delicate matter, as it can only be made on the basis of a number of assumptions. In the options presented here, it is implicitly assumed that the federal and regional PAMs have the same efficiency in terms of emission reduction per euro spent, which is not necessarily the case in practice.

2.6 Ex post versus ex ante analyses

As the time frame for the evaluation is 2008-2020, part of the assessment will be *ex post* (*i.e.* related to past years), while the biggest part of it will be *ex ante* (*i.e.* for future years[5]).

Emission projections to 2020 have been calculated year by year, in the same way as last year's study. However, there are two changes compared with last year's situation:

- more assumptions are needed, as less information is available on future developments over the period 2013-2020 than for period 2008-2012;
- lifetimes are taken into account, due to the fact that savings disappear beyond the lifetime of the relevant technical measures.

2.6.1 Assumptions on the future of the PAMs

As PAMs generally have a limited duration, assumptions are necessary as to their future development.

Two simple options could be envisaged:

[4] Although we have to underline that in some cases, the lowest financial incentive might presumably not have been sufficient to induce a significant effect without the high financial incentive.

[5] Where "future years" includes the current and past years as long as no ex post data is available for them yet.

- assume that each measure only remains in the future as long as no new decision is needed to prolong it;
- assume that, except when they have an explicit time limitation, the measures will be maintained at their current level and for the same types of purchases or investments up to the end of 2020.

The first option is a kind of Business-As-Usual (BAU) case. In this case, a PAM will survive if it has been put into legislation for an undetermined period of time. This is mostly the case of regulations and most fiscal measures, but not of subsidies, which require an annual budget decision. The advantage of this option is that it best reflects the gap in 2020 to be filled by new policies.

In the second case, the *ANRED* value of the PAM is assumed to remain constant in the future. The advantage of this option is that it gives a more interesting indication of the level of emission reduction that could be obtained in 2020.

It has been decided to opt for this second option (meeting steering committee 15 October 2010).

2.7 Measure specific approaches

The PAMs to be evaluated are diverse in nature and therefore often require different, specific approaches for their evaluation. The measure specific approaches are described in section 4 and the corresponding Excel files per measure.

3 OVERLAPPING ASSUMPTIONS

3.1 Free rider, multiplier, rebound effect

A correction for the free rider effect should in principle be made when the impact on emissions is estimated on the basis of a number of tax reductions or subsidies awarded, if a significant number of recipients of the financial support are likely to have made the emission reduction without this support.

In the framework of the EMEEES project, which developed bottom-up methodologies for evaluating energy savings in the framework of European directive 2006/32/EC, it has been recognised that this effect is difficult to evaluate, and suggested that free rider and multiplier effect might compensate each other, especially if the PAM is relatively small. This assumption seems too rough to be applicable for all federal measures of the National Climate Plan. The impact of the free rider effect has been taken into account implicitly or explicitly for the main measures for which the available data allowed it.

The multiplier effect is the fact that *e.g.* people have been led to invest in energy saving or renewable energy because they heard of financial incentives, but without actually applying for these incentives. This effect could only be taken into account when the estimated impact of a measure is based on the total actual effect of a measure, for example the promotion of railway for passenger transport.

3.2 Emission factor for energy carriers

This section recalls the assumptions made last year on this subject, which remain unchanged.

3.2.1 Electricity

One parameter that can considerably influence the estimated emission reduction is the assumption on the emission factor for electricity savings, *i.e.* the average emission per kWh of the electricity that would have been produced if the measure had not been implemented.

If the conventional electricity production can be reduced as a result of either direct electricity savings or the production of electricity from renewable energy sources, the overall emissions are reduced proportionately to the emission factor of the power plants that reduce their production (it is assumed that electricity imports and exports remain unaffected).

Assumptions made for this emission factor in the literature can vary significantly, for example between:

- the average emission factor of electricity production in the country (which in Belgium is relatively low, because of the nuclear electricity generation);
- the average emission factor of electricity production from fossil fuels;
- the emission factor of a marginal plant (*e.g.* that of a natural gas combined cycle power plant or of a coal power plant).

In this study, we have assumed that the electricity that would not have to be produced is that of a combined cycle gas turbine power plant (CCGT) burning natural gas with an overall net efficiency (52,3%) taking into account electricity transport and distribution losses. The corresponding emission factor is 381 g CO_2/kWh, which has been assumed constant up to 2020.

Actually, the marginal power station could also at times be a coal power plant or a conventional gas power plant, which have higher specific emissions. Therefore the hypothesis of a CCGT plant can be considered as a conservative value, chosen because of the uncertainty on the actual marginal plant, which will in particular depend on the future relative fuel prices.

3.2.2 Fuels

The CO_2 emission factors for natural gas and heating oil were taken from the 1996 IPCC guidelines[2].

natural gas	55,8 kg/GJ
heating oil	73,3 kg/GJ

3.2.3 Cars

In this report two CO_2 emission factors for cars are used for the baseline: one for the car stock (which is the average emission factor of all cars on the road in a given year) and one for the average new car [3].

Table 2. Average emission factor of the car stock and new cars in the baseline for the period 2008-2020 (g CO_2/km).

	Emission factor cars (g CO_2/km)	
	Car stock	**New cars**
2008	165	145
2009	163	141
2010	162	139
2011	160	136
2012	158	133
2013	156	131
2014	154	128
2015	152	125
2016	150	122
2017	148	120
2018	146	117
2019	144	114
2020	142	111

3.3 Baseline

An important assumption is the baseline to which an equipment is compared, especially when it concerns the replacement of existing equipment (case of a condensing boiler or double glazing). Two alternatives are possible:

- comparison of the new equipment with the one it replaces. In this case, the saving calculated is an overall effect, *i.e.* not only the saving induced by the PAM but also that arising from the fact that old equipment is being replaced by new;
- comparison of the new equipment with the equipment that would have been purchased in absence of the PAM. In this case, only the effect of the PAM is considered.

Following the methodology proposed in the framework of the ESD directive [3], the second option has been retained. It should be noted that for some measures this baseline depends on the time period.

3.4 Number of degree-days

One change compared to the previous study relates to the number of degree days. It has been decided to use the same assumption as for the ESD directive, which is 1946 degree-days in basis 15/15 (average of the last 25 years). Note that in the previous study we had considered 2415 degree-days in basis 16,5/16,5 as recommended by the Natural Gas Federation in [4].

3.5 Lifetimes

Lifetimes are used in the projections in order to take into account the duration of annual emission reductions generated by investments. As far as possible we use the lifetimes agreed upon in the framework of EU directive 2006/32/EC[6].

4 CALCULATIONS

4.1 Evaluation category by measure

The evaluation category of each measure is given in the table below.

Table 3. Evaluation category by measure

Code	***Title***	***Evaluation category (*)***
EP-A01	Green certificates	2
EP-A02	Financial support for electricity generation from RES	2
EP-A03	Stopping the exemption from excise & establishment of an excise duty on energy for coal and heavy fuel oil products	8
EP-A05	Action Plan for renewable energy and CHP: offshore wind	8
EP-B01	Specific improvement for allocation of emission quotas to power producers	5
EC-A05	Promotion of energy efficiency of electric appliances	5
EC-B01	Financial incentives for the rational use of energy (RUE) and RES	
	condensing boiler	1
	heat pump	1
	double glazing	1
	roof and wall insulation	1
	thermostatic valves or time regulated thermostats	2
	energy audit	3

[6] European Commission: Recommendations on measurement and verification methods in the framework of directive 2006/32/EC on energy end-use efficiency and energy services – Preliminary Draft Excerpt, July 2010.

Code	*Title*	*Evaluation category (*)*
	solar thermal systems	1
	PV systems	2
	passive houses	1
EC-B02	Specific constraints on boilers	5
EC-B03	Specific RUE aid for unprivileged people	4
EC-B04	Improve the information available to the consumer on the environmental impact of products	7
EC-C01	Using a third investor funds in the public sector	2
IP-A06	Specific financial measures and ecology grants	4
IP-B01	Reducing the use of fluorinated greenhouse gases : HFCs, PFCs	7
TR-A01	Mobility plans at local level	3
TR-A02	Improve and promote public transport	2
TR-A03	Promoting the bicycle use	2
TR-A04	Promoting multimodal systems for goods	4
TR-A08	Free public transport for commuters	8
TR-B01	Promotion of car-pooling	4
TR-B03	Promote teleworking	6
TR-B05	Eco-driving	4
TR-C01	Tax deduction on the purchase of clean vehicles	2
TR-C02	Promoting the purchase of clean vehicles	8
TR-D01	Tax exemption of biofuels	2
AG-C02	Preservation of the ecological stability of forests	6
AG-D04	Quality standard of solid biofuels	6
AG-E01	Monitoring of biomass	6
WA-A01	Minimise quantity of waste into landfill	5
SE-A01	Climate change awareness	3
SE-A02	REG and promotion of renewable energy applications	3
SE-A03	Environmental Care at School (MOS project)	3
SE-A07	Action to support local initiatives	3
SE-A08	Urban Policy	3
OB-A01	Sustainable public procurement	3
OB-A02	Optimization of catering on the basis of sustainability criteria	5
OB-A03	Establishment of an environmental management system	4
OB-B01	RUE in public buildings, strictly speaking	
	RUE strictly speaking	2
	Energy production through renewable energy	2
	Buying green electricity	6
OB-B02	Use of the third investor	8
OB-C02	Stimulating of alternative use in transport	2
OB-C03	Promotion of bicycle use	8
OB-C04	Teleworking	2
OB-C07	Purchase of clean vehicles	4
	Green loans	8
	Ecocheque	2

(*) 1: EC formula; 2: Alternative formula; 3: Impact included under other measures; 4: Order of magnitude; 5: Neglected; 6: Not relevant; 7: Not quantifiable; 8: Impact included under a single other measure.

4.2 Excel template

Emission reduction calculations have been carried out only for quantifiable PAMs (evaluation categories 1,2 and 4 in (Table 3), for which an Excel template has been used. The list of Excel templates that have been established is given in Annex 2.

The impact of the measures for which no separate calculations have been performed is either included under another measure or not estimated (generally because it is not easy to estimate and not very significant). The situation for each measure is described in the next section.

The Excel template is used for the detailed calculation of the greenhouse gas emission reduction (in terms of CO_2 eq) for each of the years in the period 2008-2020.

A similar format is used for each PAM, adjusted based on the specificities and available data (both the complexity and the level of detail needed can differ considerably from one measure to the other). Each Excel file includes a description of the hypotheses and inputs needed.

For clustered measures, the reduction is first calculated at the clustered level, and then an estimate for the division between the linked measures has been made, based on assumptions discussed in the steering group.

4.3 Overview by measure

4.3.1 EP-A01 & EP-A05 Offshore wind energy**

Description

With a view to ensuring the placing on the market of a minimum volume of green electricity, a system of green and CHP certificates was established, both at regional and federal levels. Electricity suppliers are obliged to have a minimum percentage of their electricity sales produced from renewable energy sources. A minimum price has been fixed for green certificates. The federal level ensures a minimum price guarantee.

On 21 March 2004, the federal Council of Ministers set a target of 2.000 MW for electricity from offshore wind in 2020. A contribution of the grid operator is introduced (financing for network expansion, purchase of certificates). The Federal government guarantees project investments in case of interruption by authorities. In 2008, the Federal government has also decided to simplify procedures for wind energy projects.

Assumptions & calculation

The general approach used to calculate the impact of this measure on CO_2 emission reductions is:

$$C \times H \times EF_{CCGT} \times A$$

With:

C	the average installed capacity
H	the equivalent number of working hours at full load per year
EF_{CCGT}	the emission factor of a CCGT installation (g CO2/kWh)
A	allocation factor (to the federal policies)

For the period 2008-2010 we have used information provided by the FPS economy on the actually installed capacity of offshore wind energy. For the period 2011-2020 we have used the prognoses provided by the FPS economy. This includes that 2.000 to 2.130 MW will be operational in 2020. As in the previous report, we have assumed that 2.000 MW will be operational in 2020 for the calculation of the total savings, which was requested by the steering committee [5]. We have used the projections provided by the FPS economy that assume 3.100 full load hours for offshore wind energy. This is on the lower end of the scale, for which there are estimations up to 3.500 hours.

The expected life time of offshore wind turbines is estimated to be 20 years, which exceeds the time frame.

As offshore wind energy is solely the responsibility of the Federal government, 100% of the emission reductions are allocated to the federal level.

Results

The calculated emission reduction by offshore wind energy, based on the above assumptions, is an estimated 2.356 kton CO_2-eq in 2020. Compared to the previous report the cumulative savings over the period 2008-2020 has decreased from 15.300 to 12.900 kton. This is mainly caused by changes in the projected installed capacity in the period 2011-2014.

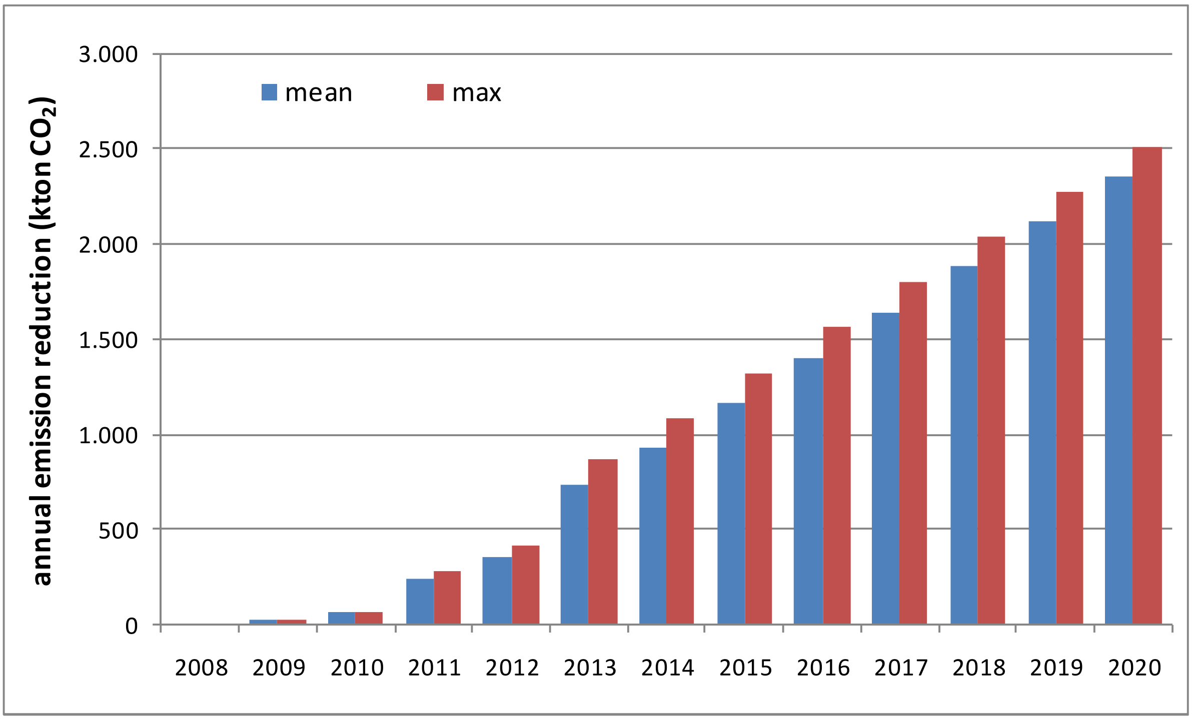

Figure 3. Results for EP-A01

4.3.2 EP-A02 & EP-A03 Tax on fossil fuels for electricity production**

Description

In addition to the Green Certificates scheme, the Belgian authorities have implemented several measures to promote the generation from renewable energy sources (RES). RES and CHP producers enjoy priority access to the grid in all regions. The regions offer ecology grants that can be cumulated with the federal measures. The Federal government has also taken a number of additional measures which reduce the relative cost of electricity from RES. It has established a special excise tax on fossil fuel for electricity production in 2004: 15 €/ton for heavy oil and 8,65 €/ton for coal and an additional 'Cotisation sur l'énergie/Bijdrage op energie' of 3 €/ton of coal. In parallel it has ended the system of excise duty exemptions for coal, coke, lignite and heavy fuel oil, which were previously exempt from excise duty for electricity production (EP-A03).

Assumptions & calculation

The excise tax on coal makes both natural gas and biomass relatively more attractive for electricity production. In this study we have only quantified the impact related to a shift from coal to biomass[7].

[7] The impact of the measures on a shift from coal to natural gas for electricity production is too complex to evaluate here, because the decisions of electricity producers on the fuel mix depend on the coal and gas prices, availability of power plants, the electricity demand level, which all are a function of time.

For this shift from coal to biomass, there is an overlap with the regional green certificate system, which is an important financial incentive promoting biomass use in coal fired power plants, and the European Emission Trading Scheme (EU ETS). Regional authorities are responsible for the allocation of allowances in the period 2005-2012. We have therefore also taken a fixed carbon price into account. As explained in chapter 3 on methodology, the impact has been allocated between the federal PAM and the regional ones proportionately to the relative size of the impact of these measures on the cost of electricity production.

The taxes on coal result in an increase of electricity production costs from coal estimated at 4,4 €/MWh (see Figure 4). The green certificate system results in a decrease of electricity production costs from biomass estimated at 63 €/MWh. The ETS has resulted in an increase of the cost of an estimated 15,7 €/MWh (based on 16,5 €/ton CO_2). Thus, the difference in the cost of electricity production between coal and biomass was decreased by a total of 83 €/MWh due to these PAMs. Therefore, 5,3% of the emission reduction was allocated to the federal PAM.

In 2008, an estimated 1.562 GWh of electricity was produced with biomass in coal fired power plants. Two scenarios were considered:

- no increase of biomass electricity production for 2010-2020 compared to 2009;
- a linear increase of co-combustion of biomass (corresponding with an annual increase of 177 GWh), until the production reached 2.811 GWh. This maximum is based on a maximum increase of biomass cogeneration in Flanders up to 2.179 GWh [6].

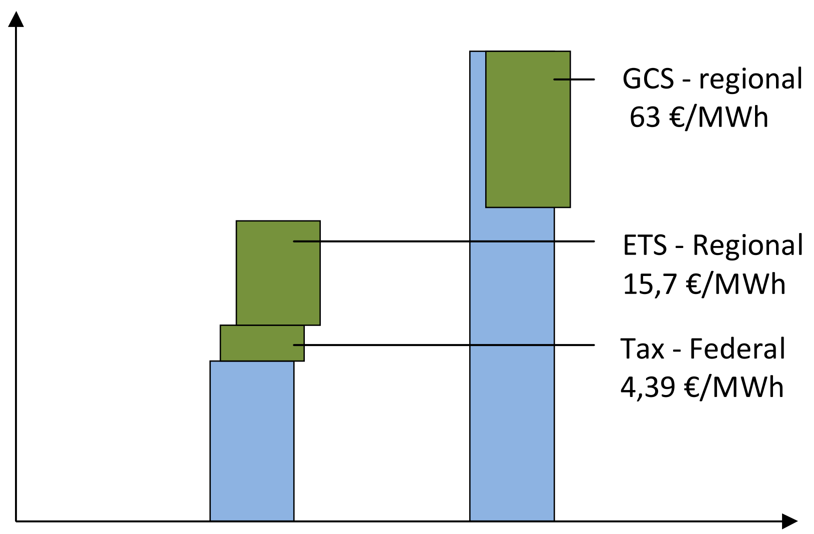

Figure 4. Illustration of the impact of the excise tax on coal on the electricity production cost

As shown on the figure, the Federal tax on coal and the regional green certificate scheme respectively increase the cost of producing 1 MWh electricity from coal and decrease the cost for producing a similar amount of electricity from biomass. The overall effect of both federal and regional measures is that producing 1 MWh electricity with biomass has become 67 € cheaper as compared with coal.

The emission reduction for the federal measure is:

$$EP_{biomass} \times EF_{coal} \times A$$

With:

$EP_{biomass}$	Electricity production from biomass
EF_{coal}	Emission factor of a coal-fired power plant
A	Allocation factor

Results

In the min scenario (no increase after 2009) the annual emission reduction is 87 kton CO_2/year in 2008 and 101 kton CO_2/year for 2009-2020, which amounts to a cumulative emission reduction over the period 2008-2020 of 1.297 kton CO_2. In the max scenario (a linear increase of co-combustion of biomass) the cumulative emission reduction increases to 1.642 kton CO_2 (Figure 5).

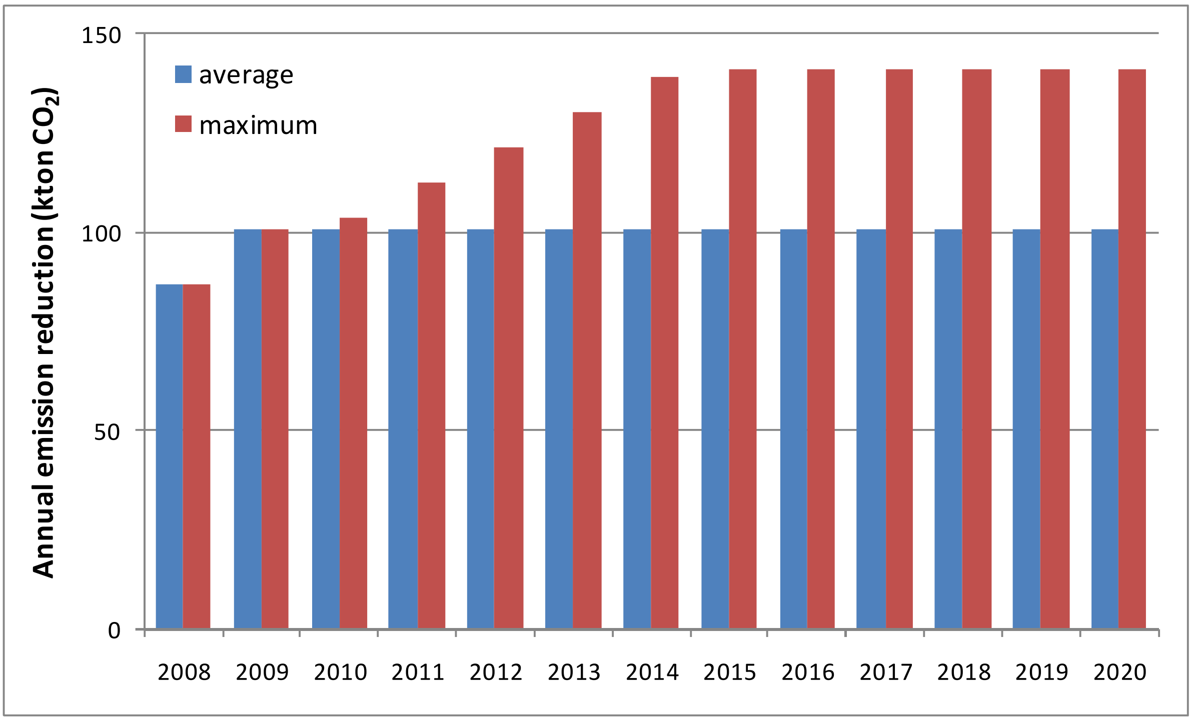

Figure 5. Results for EP-A02 in the min and max scenario.

4.3.3 EP-B01 Prior authorization for power plants > 25 MW

Description

The Belgian allocation plan is the compilation of 3 Regional allocation plans. Additionally, prior authorization of the Federal government is required for any new installation that develops more than 25 MW (also for expanding plants). The criteria are based on: needs, network integration, use of BAT, choice of fuel,… The methods of calculating the number of ETS allowances vary by region.

Assumptions & calculation

Since October 2000, increases or new production capacity for electricity generation exceeding 25 MW requires a formal approval by the Federal government [7]. In the absence of evidence against it, we assume that the authorization does not have a dissuasive effect and that it does not influence the installations directly.

4.3.4 EC-A05 & EC-B04 Labels on energy efficiency

Description

The Federal government supports initiatives to assess the effectiveness of labels to inform consumers correctly. It develops methodologies (indicators, standard...) for consumer protection as part of the information on environmental impacts. A revision of the code of environmental advertising is also planned.

Assumptions & calculation

Considering that this is a study into the effectiveness of labels, without additional measures being proposed to change the labelling, no effect of this measure can be quantified.

4.3.5 EC-B01 Financial incentives for rational use of energy**

4.3.5.1 General methodology

Description

Tax deductions and subsidies have been granted for part of the cost of investments aiming to increase energy efficiency in households (including the use of renewable energy resources).

Assumptions & calculation

The general approach (see also Figure 6) used to calculate the total CO_2 reduction for this measure per year is as follows:

$$\sum_i (N_t \times P_i \times ER_i \times A_i)$$

With:

- Σ summation for all types of investments eligible under EC-B01
- N_t cumulative number of tax deductions per year since 2004
- P_i distribution between investments or technologies (%)
- ER_i unit CO_2 reduction per investment (kg)
- A_i allocation to federal measure per investment (%)

The reduction of investments done from 2004 are taken into account.

Free rider and multiplier effect are assumed to compensate each other [8]. The rebound effect is assumed to have no impact.

The different parts of the formula are discussed in the following sections.

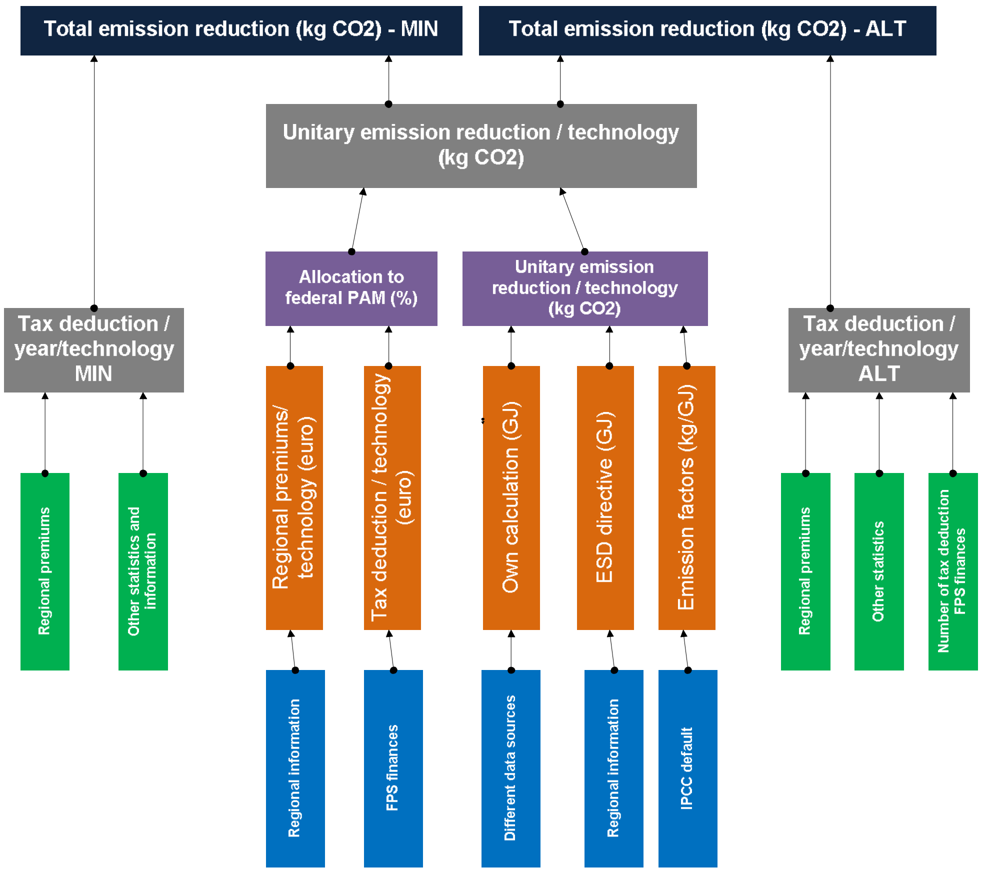

Figure 6. Schematic overview of the calculation method for EC-B01

We recalculated the results in comparison with the previous report (April 2011) , due to changes in:

- The total number of tax deductions in 2008 was now available. This changed the alternative amount of tax deductions described in Table 6.
- We updated the unitary saving per technology, based on the unitary savings calculated by Flanders for the Flemish Energy Efficiency Action Plan.

We also received information on the number of reduction per technology (boiler replacement, roof insulation, double glazing, and floor and wall insulation) used in the Energy Efficiency Action Plan for Wallonia and Flanders. We compared these data with the number estimated in the minimum scenario, and since the divergence (especially in 2009, which is kept constant for the following years) is relatively small, we decided not to change the estimates in the minimum scenario. In the following figure, the comparison is presented (for floor and wall only the years 2009 and 2010 are of importance).

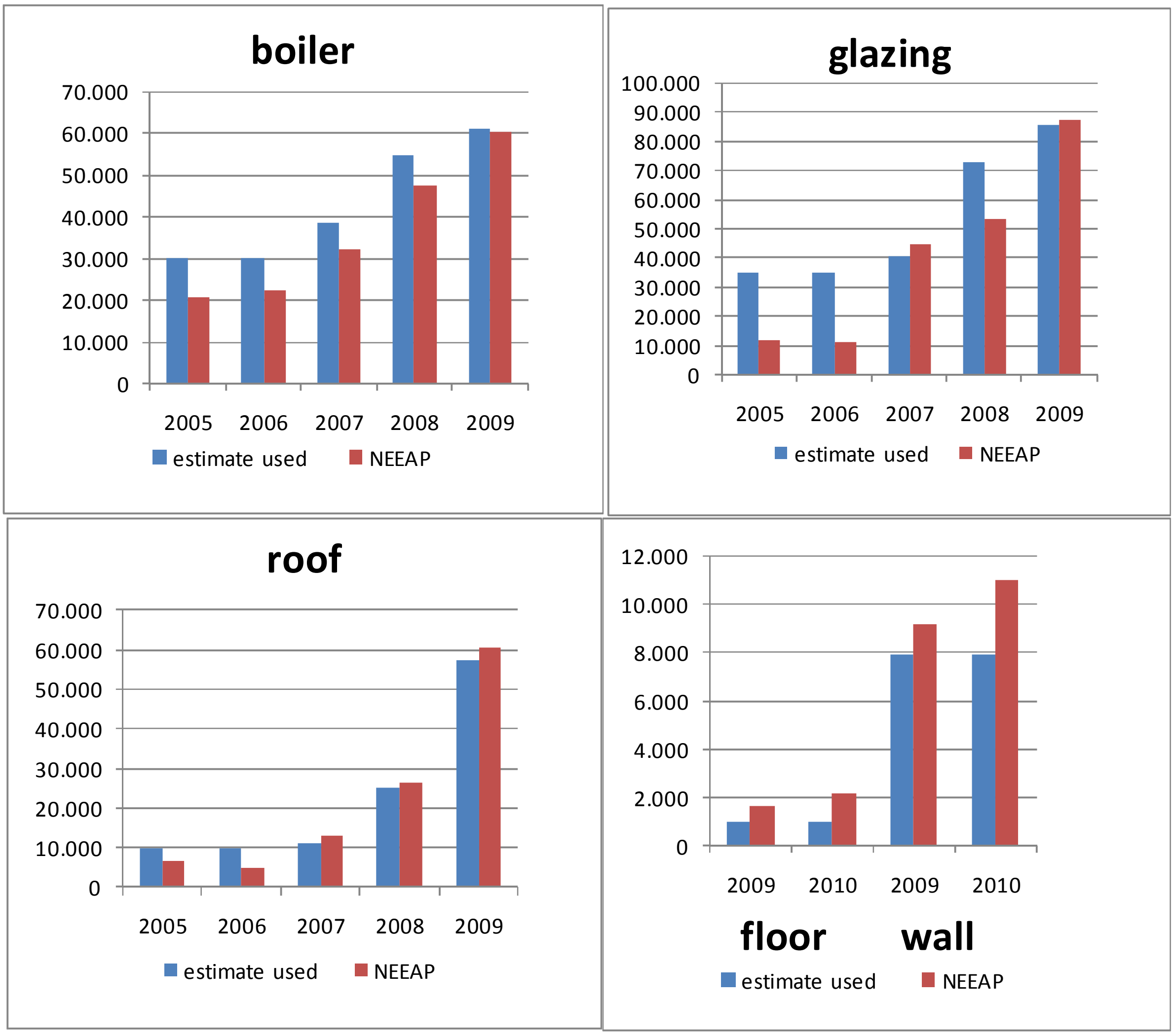

Figure 7. Comparison between the estimated used in the minimum scenario and the data received from the Energy Efficiency Action Plans of Flanders and Wallonia (for Brussels, the estimates are the same in both data sets)

4.3.5.2 Number and distribution (%) of tax deductions among types of technology

The number of tax deductions within EC-B01 was provided by the FPS Finance [9], for the years 2003 to 2008. The data are listed in Table 4.

From income year 2009, taxpayers are allowed to spread the fiscal deductions over 3 years. For the data received from the FPS, this was not the case yet. Also, a tax credit has been introduced for non-tax payers from 2009.

Unfortunately, in the federal tax deduction data of the FPS Finance no distinction can be made among equipments or technologies (except for passive houses in 2007).

We have considered two alternative scenarios:

- a minimum scenario;
- an alternative scenario.

Table 4. Information on tax deductions (FPS Finance).

# requests	**Bxl**	**Fl**	**W**	**TOTAL**
2003	5.820	64.700	26.242	96.762
2004	6.969	84.549	31.408	122.926
2005	10.163	122.030	47.378	179.571
2006	19.244	202.557	119.857	341.658
2007	24.773	277.023	162.251	464.047
2008	-	-	-	627.552
MEUR				
2003	2,80	26,13	11,65	40,58
2004	3,59	66,37	14,35	84,30
2005	5,79	57,57	24,05	87,41
2006	11,65	122,38	54,17	188,20
2007	20,34	243,03	97,15	360,53
2008	-	-	-	519,22

In the **minimum scenario** we have made an estimation of the number of tax deductions per technology based on available (although in some cases partial) information of the regional grants [10, 11] and the number of PV installations from the CWAPE and VREG websites.

In short:

1. Boiler replacement: we have taken into account the number of condensing boilers:
   a. for Flanders, we have used information for 2007 to 2009 from the annual reports of the grid managers (approx. from 26.000 in 2007 to 47.000 in 2009);

   b. for Wallonia we have estimated an annual installation of 10.000 new condensing boilers between 2007 and 2009 and;
   c. for Brussels we have used the number of grants (rising from approx. 2.000 in 2007 to 4.500 in 2009).

   It is not always clear if these data only include residential boilers or not. As such, these data only give us a raw estimate for the years 2007 to 2009. After 2009, we have kept the annual replacements constant. For 2004 to 2006, we have estimated the number at approximately 30.000 per year for all regions.
2. Heat pump: we have used data from the regional grants to make an estimate: 572 in 2007 to an estimated 917 in 2009. We have kept this number constant after 2009. For the years 2004 to 2006, we have estimated the number of installations: from 100 in 2004, over 250 in 2005 to 500 in 2006.
3. Double glazing: some data from the regional grants were available. It is not always clear if the replacement of glass only refers to residential buildings or not. In 2007, approximately 40.500 replacements have been made, increasing in 2009 to more than 85.000. We have kept the number of 2009 constant in the future years. For the years 2004-2006, we have used an estimate of 35.000 replacements per year.
4. Roof insulation: again, we have some data from the regional grants. It is not always clear if these only refer to residential buildings or not. In 2007, approximately 11.000 grants were awarded, increasing in 2009 to more than 57.000. We have kept the number of 2009 constant in the future years. For the years 2004-2006, we have used an estimate of 10.000 roof insulations per year.
5. Thermostats: we have some data from the regional grants. It is not always clear what exactly is included, so we have taken into account all ‘regulations of heating systems’. The number rose from over 14.000 in 2007 to more than 22.000 in 2009. We have kept the number of 2009 constant in the future years and have estimated the number for 2004 to 2006 at approximately 12.000 a year.
6. Energy audits: have no impact as such on the emission reduction. We have information from the regional grants: approximately 700 in 2007 to 2.500 in 2009. We have kept the number for the future constant and estimated for the years 2004 a 2006 a number of 700 audits per year.
7. Solar boiler: for Flanders and Brussels we have data from the regional grants from 2007 to 2009. For Wallonia we could make an estimate based on the number of m^2 installed based on the regional inventory of renewable energy. For all regions together, we have estimated that more than 7.000 solar boilers were installed in 2007, increasing to almost 9.000 in 2009. We have kept this amount constant for the years after 2009. For the years 2004 – 2006, we estimated the number at 1.000 in 2004, 3.000 in 2005 and 5.000 in 2006.
8. PV: In 2009 more than 59.000 installations were installed in Flanders, Wallonia and Brussels. In 2007 and 2008 the numbers were much lower. This was based on information from the websites of the VREG, CWAPE and regional grants from Sibelga in Brussels [10]. We have kept this estimate the same for 2010 and 2011. After that, we presume that this number will decline to 30.000 new installations per year (since in Flanders subsidies will decrease and the number

of new installations is also likely to decrease). For the years prior to 2007, we have estimated the number at 100 in 2004, 500 in 2005 and 1.000 in 2006.

9. Passive houses: We have included here also low energy and zero energy houses. The data from FPS show 406 houses in this category in 2009. We have kept this number constant for all years.
10. Floor insulation: only applicable for income years 2009 and 2010. Based on data from regional grants, we have calculated that there were about 1.000 floor insulations per year due to this tax deduction.
11. Wall insulation: also only applicable for income years 2009 and 2010. Based on data from regional grants, we have calculated that about 7.900 insulations per year were performed.

The exact numbers we have used can be found in Table 5.

Table 5. Distribution of tax deduction in minimum scenario.

Income year	*Condensing boiler*	*HEat pump*	*Double glazing*	*Roof insulation*	*Thermostatic vavles*	*EAP*	*Solar boiler*	*PV panels*	*Passive house*	*Floor insulation*	*Wall insulation*	*TOTAL*
2004	30.000	100	35.000	10.000	12.000	700	1.000	100	406			**89.306**
2005	30.000	250	35.000	10.000	12.000	700	3.000	500	406			**91.856**
2006	30.000	500	35.000	10.000	12.000	700	5.000	1.000	406			**94.606**
2007	38.746	572	40.594	11.112	14.341	724	7.121	5.664	406			**119.280**
2008	54.908	813	72.962	24.864	19.992	2.490	8.470	14.026	406			**198.931**
2009	61.336	917	85.578	57.230	22.311	2.533	8.832	59.236	406	982	7.909	**307.269**
2010	61.336	917	85.578	57.230	22.311	2.533	8.832	60.000	406	982	7.909	**307.269**
2011	61.336	917	85.578	57.230	22.311	2.533	8.832	60.000	406			**298.379**
2012	61.336	917	85.578	57.230	22.311	2.533	8.832	30.000	406			**269.143**
2013	61.336	917	85.578	57.230	22.311	2.533	8.832	30.000	406			**269.143**
2014	61.336	917	85.578	57.230	22.311	2.533	8.832	30.000	406			**269.143**
2015	61.336	917	85.578	57.230	22.311	2.533	8.832	30.000	406			**269.143**
2016	61.336	917	85.578	57.230	22.311	2.533	8.832	30.000	406			**269.143**
2017	61.336	917	85.578	57.230	22.311	2.533	8.832	30.000	406			**269.143**
2018	61.336	917	85.578	57.230	22.311	2.533	8.832	30.000	406			**269.143**
2019	61.336	917	85.578	57.230	22.311	2.533	8.832	30.000	406			**269.143**
2020	61.336	917	85.578	57.230	22.311	2.533	8.832	30.000	406			**269.143**

The total calculated number of tax deductions per technology is lower than the data from the FPS Finance. The reasons for this discrepancy are:

- The number of grants might be lower than the number of tax deductions, if people do not apply for the regional grants.
- The data of FPS Finance on number of tax deductions include tax deductions for the maintenance of the heating system, which are also allowed. This is not covered by

the regional grants. The energy savings and CO_2 emission reductions of this maintenance are negligible, so they were not taken into account any further.

For the **alternative scenario**:

- We have made an estimate of the number of boiler replacements, solar boilers, PV and passive houses based on statistics (*e.g.* sales statistics, VREG, CWAPE) and regional grants.
- We have estimated the number of tax deductions for the maintenance of heating systems.
- These estimates (boiler replacements, solar boilers, PV, passive houses and maintenance of heating system) were subtracted from the total number of tax deductions from the FPS . The remaining part of tax deductions was divided among the remaining technologies (glass replacement, roof insulation, floor and wall insulation (2009 and 2010 only), thermostats and EAP).

In short:

1. Boiler replacement: based on sales statistics used in a study on the emissions from the heating sector [12], we have estimated the number of condensing natural gas boilers in the residential sector by using the total sales minus the number of newly built houses with natural gas as primary energy source [13]. For the sales statistics, we have assumed that 80% is for residential use. This resulted in a total of approximately 4.000 condensing natural gas boilers in existing houses annually installed in 2006, increasing to a total of approximately 70.600 annually installed in 2009. We have kept this number constant after 2009. We did not take into account the small amount of condensing boilers on heating oil.
2. Solar boiler: we have kept the same estimate as in the minimum scenario.
3. PV: we have kept the same estimate as in the minimum scenario.
4. Passive houses: we have kept the estimate of 406 passive houses in 2004 until 2007 as in the minimum scenario. In 2008, we have estimated a 1.000 passive houses (about 2% of total newly built houses) and let the number increase linearly to 2.500 passive houses in 2020.
5. Maintenance of heating system: for 2004, we have assumed that the number of tax deductions for only the maintenance of the heating system is zero. In 2005, we have assumed 50.000 tax deductions (approximately 1,6% all central natural gas and heating oil systems in Belgium). From 2006 onwards, we have assumed 100.000 tax deductions (or approximately 3% of all natural gas or heating oil systems).

We then subtracted the above estimates from the total number of tax deductions, and distributed the remaining number over the rest of the technologies, using estimates based on the distribution of the regional grants over these technologies. The remaining technologies are: double glazing, roof insulation, thermostats, heat pumps, energy audits, wall and floor insulation (only in 2009 and 2010).

In Table 6, the estimates used in the alternative scenario are shown. The number of tax deductions in the minimum and alternative scenarios were used in the overall Monte Carlo analysis, assuming a uniform distribution.

4.3.5.3 Unit CO_2 reductions per investment/equipment/technique

As already mentioned, it has been decided to use the same methodology as for the National Energy Efficiency Action Plan in the framework of the ESD directive. Flanders allowed us to use the available information on the unit energy savings that have been used in their regional plan (updates from September 2011).

There are two baselines: the average existing stock in 1995 for investments made in the years prior to 2008, and the average existing stock in 2007 for investment made from 2008 onwards.

In
Table **7**, we have compared the unit energy (and CO_2) savings from the previous report (April 2011) and the current one. We also indicated when there is a method or data available from the Flemish Energy Efficiency Action Plan. The coloured cells are the data (average unit CO_2 savings) used in the previous report (orange) compared to the ones used in the current report (green). The more detailed data are available in the Excel file.

Table 6. Assumptions on total number of tax deductions (alternative scenario)

Income year	***Condensing boiler***	***heat pump***	***Double glazing***	***Roof insulation***	***Thermostat ic vavles***	***EAP***	***solar boiler***	***PV panels***	***Passive house***	***Floor insulation***	***Wall insulation***	***TOTAL***
2004	0	1.135	66.248	21.593	28.953	3.491	1.000	100	406			**122.926**
2005	0	1.174	68.564	22.348	29.965	3.614	3.000	500	406			**129.571**
2006	4.004	2.161	126.171	41.124	55.142	6.650	5.000	1.000	406			**241.658**
2007	25.518	3.494	175.543	50.878	89.112	6.312	7.121	5.664	406			**364.047**
2008	55.890	3.563	247.229	89.315	90.981	17.079	8.470	14.026	1.000			**527.552**
2009	70.619	1.704	188.247	144.817	30.523	0	8.832	59.236	1.125	1.242	11.741	**527.552**
2010	70.619	3.150	188.186	144.771	21.238	8.861	8.832	59.236	1.250	1.184	11.194	**527.552**
2011	70.619	3.333	188.126	144.724	41.931	9.376	8.832	59.236	1.375			**527.552**
2012	70.619	3.584	202.259	155.597	45.081	10.080	8.832	30.000	1.500			**527.552**
2013	70.619	3.583	202.198	155.550	45.068	10.077	8.832	30.000	1.625			**527.552**
2014	70.619	3.582	202.137	155.503	45.054	10.074	8.832	30.000	1.750			**527.552**
2015	70.619	3.581	202.077	155.457	45.040	10.071	8.832	30.000	1.875			**527.552**
2016	70.619	3.579	202.016	155.410	45.027	10.068	8.832	30.000	2.000			**527.552**
2017	70.619	3.578	201.955	155.363	45.013	10.065	8.832	30.000	2.125			**527.552**
2018	70.619	3.577	201.895	155.317	45.000	10.062	8.832	30.000	2.250			**527.552**
2019	70.619	3.576	201.834	155.270	44.986	10.059	8.832	30.000	2.375			**527.552**
2020	70.619	3.575	201.773	155.223	44.973	10.056	8.832	30.000	2.500			**527.552**

Table 7. Comparison of unit savings with the previous study for measure EC-B01

(per investment)	**EC B01 (April 2011)**	**EC B01 (September 2011)**	**ESD formula**	**remark**
condensing boiler			yes	
unit energy saving (GJ)				
baseline 1995	56,8	47,8		we calculated an average, based on assumptions of occurence of replacements
baseline 2007	27,2	27,2		
average CO_2 reduction (kg)				
baseline 1995	4.711	3.057		we calculated an average, based on assumptions of occurence of replacements (crystal ball results)
baseline 2007	2.622	1.832		
heat pump			no	
unit energy saving (GJ)	63,3	Id		change in energy need due to system efficiencies that were adjusted to the data used in the EE
average CO_2 reduction (kg)	2.202	Id		Crystal ball result
double glazing			yes	
unit energy saving (GJ/m^2)	from 12 (2004) to 7 (2020) GJ - replacement of single glass; from 18 (2004) to 12 (2020) GJ – replacement of double glass	from 12 (2004) to 7 (2020) GJ - replacement of single glass; from 16 (2004) to 11 (2020) GJ - replacement of double glass		
unit energy saving (GJ)				double glass is higher, due to higher m2 that is replaced
average m^2				
average CO_2 reduction (kg)	from 994 (2004) to 665 (2020)	from 932 (2004) to 633 (2020)		Crystal ball results (taking into account different % of occurrence for single or double glass replaced)
roof insulation			Yes	
unit energy saving (GJ/m^2)				
baseline 1995				
baseline 2007				
unit energy saving (GJ)	from 38 (2004) to 24 (2020)	from 52 (2004) to 31 (2020)		
average m^2				
average CO_2 reduction (kg)	from 2.830 (2004) to 1.665 (2020)	from 2.507 (2004) to 1.517 (2020)		
thermostats			No	
heat demand (MJ)				
baseline 1995	118.699	105.730		because the energy need has changed (higher value), the average reduction has risen also.
baseline 2007	105.307	90.830		

average CO_2 reduction (kg)				
baseline 1995	393	336		Crystal ball calculations
baseline 2007	350	279		
solar thermal			Yes	
average CO_2 reduction (kg)	358-301	Id		
PV			Yes	
average CO_2 reduction (kg)	809	Id		
passive house			No	
average CO_2 reduction (kg)	2.415	Id		energy efficiency of heating system in new houses and energy need of new house has been slightly adjusted (crystal ball calculation)
floor insulation			Yes	Although there is a method available in the Flemish Plan, we have not used so far
unit energy saving (GJ/m^2)				
baseline 1995	0,05			
baseline 2007	0,04			
unit energy saving (GJ)				
baseline 1995	3,51			
baseline 2007	3,08			
average m^2	73,7			
average CO_2 reduction (kg)				
baseline 1995	202	Id		Crystal ball calculations
baseline 2007	177	Id		
wall insulation			Yes	
unit energy saving (GJ/m^2)				
unit energy saving (GJ)	from 33 (2004) to 32 (2020) GJ	from 27 (2004) to 24 (2020) GJ		
average m^2	106,6			
average CO_2 reduction (kg)	from 2.186 (2004) to 2.179 (2020)	from 2.070 (2004) to 2.079 (2020)		

In the following sections, we will discuss in more detail the assumptions to calculate the unit savings per technology.

4.3.5.4 Condensing boiler

For this group of tax deductions, it is also possible to get a tax deduction for the maintenance of the heating system. We consider the corresponding energy saving and CO_2 reduction to be negligible. As a unit reduction we have calculated the replacement of an old system by a new system based on natural gas. We have based our calculation on the harmonised methodologies proposed by the EU for the ESD directive. This uses 2 baselines for 'old' systems: 1995 and 2007 (see section 4.3.5.3). The new system is either a high efficiency or a condensing boiler on natural gas.

The unit emission reduction (in GJ per boiler) is calculated as:

$$ER\ condensing\ boiler = Q\ X\ \left(\frac{1}{\eta\ before} - \frac{1}{\eta\ after}\right) X\ EF =$$

$$\frac{(24\ X\ 3{,}6\ X\ DD\ X\ (U\ X\ A\ + 0.34\ X\ n\ X\ V) X\ d}{1.000.000}\ X\ \left(\frac{1}{\eta\ before} - \frac{1}{\eta\ after}\right) X\ EF$$

With:

$ER_{condensing\ boiler}$	unit emission reduction for condensing boiler (kg)
Q	heat demand (MJ/year)
EF	weighted emission factor, depending on which replacements are made (kg/MJ)
U	average heat loss coefficient (W/m^2K)
A	average loss area (m^2)
DD	number of heating degree days (1946)
n	ventilation (volume/h), depending on the age of the building
V	heated volume (m^3)
d	correction factor for temperature reductions during night (86% for 75% of the time)
η_{before}	system efficiency heating before replacement (%)
η_{after}	system efficiency heating after replacement (%)

The specific values in the formula are those of the Flemish household model [14] , and the energy reductions used for the calculation in this study are directly taken from the model. Only the multiplication with the appropriate emission factors was done outside the model, depending on the types of replacement considered.

The % of types of replacements are assumed to have a triangular probability distribution for the Monte Carlo analysis. The unit savings are considered to have a normal distribution, with a 10% standard deviation.

Table 8. Assumptions used in the calculation of the CO_2 unit reduction for replacement of boilers – baseline 1995

Input parameter	Min	Mean	Max	Source
% type of replacement				
NG old by NG ER+	0%	5%	10%	Estimated
NG old by NG condensing	Calculated by difference			
HO old by NG ER+	5%	10%	15%	Estimated
HO old by NG condensing	10%	35%	50%	
Unit energy saving per type of replacement (GJ)				
NG old by NG ER+		30,0		Based on data Flanders (EE)*
NG old by NG condensing		38,0		Based on data Flanders (EE)*
HO old by NG ER+		52,0		Based on data Flanders (EE)*
HO old by NG condensing		63,0		Based on data Flanders (EE)*

*data September 2011

Table 9. Assumption used in the calculation of the CO_2 unit reduction for replacement of boilers – baseline 2007.

Input parameter	Min	Mean	Max	Source
% type of replacement				
NG old by NG condensing	Calculated by difference			
HO by NG condensing	20%	40%	60%	
Unit energy saving per type of replacement (GJ)				
NG old by NG condensing		16,0		Based on data Flanders (EE)*
HO by NG condensing		44,0		Based on data Flanders (EE)*

*Data September 2011

The emission factors used for the different fuel types are the IPCC default values, which are kept constant. The Monte Carlo analysis gave a CO_2 unit reduction for **baseline 1995** of **3.057 kg CO_2**, with a standard deviation of 208. For the **baseline 2007**, the unit CO_2 reduction is **1.832 kg CO_2** with a standard deviation of 192.

4.3.5.5 Heat pump

The CO_2 reduction for the installation of a heat pump is calculated using the following formula:

$$E_{baseline} - C \times H \times \frac{3,6}{COP} \times EF$$

With:

$E_{baseline}$	average CO_2 emission of baseline (kg)
C	average capacity (kWth)
H	number of equivalent full load working hours (h)
EF	emission factor of CCGT power plant (kg/kWh)
COP	coefficient of performance (yearly average)

The reference situation or baseline in this case, is the average fuel mix used for heating purposes in new houses in Belgium.

The correction for electricity use, is based on the coefficient of performance of the heat pump (COP, ratio of the useful heat to the electricity consumption) and the average CO_2 EF for electricity produced in a CCGT plant.

In the following table, the input parameters and their minimum and maximum value are presented. These are mostly based on expert judgement, data from literature or from the data used in the methods developed by Flanders for the ESD directive (performances). They are assumed to have a triangular distribution.

Table 10. Assumptions used in the calculation of the CO_2 unit reduction for heat pumps.

Input parameter	Min	Mean	Max	Source
capacity installation (kWth)	6	8	10	Estimated, based on [15]
working hours (h/y)	1.500	2.000	2.500	Estimated based on [15]
COP	2,5	3,5	4,5	Estimated based on [15]
CO_2 EF electricity production (kg CO_2/MWh)	0,34	0,38	0,42	See General assumptions
% of occurence in new buildings				
NG ER+	0,41	0,51	0,61	Estimated
NG ER top	Calculated by difference			
heating oil optimaz	0,11	0,21	0,31	Estimated
heating oil elite	0	0,10	0,2	Estimated
Performance η30%				
NG ER+	86%	95%	100%	See condensing boiler
NG condensing	86%	95%	100%	See condensing boiler
heating oil Optimaz	75%	83%	91%	See condensing boiler
heating oil Elite	75%	83%	91%	See condensing boiler

The data used for each parameter and the source are described in the Excel file.

The Monte Carlo analysis gave a CO_2 unit reduction **of 2.202 kg CO_2**, with a standard deviation of 410.

4.3.5.6 Double glazing

For double glazing, Flanders has calculated (preliminary model results) unit energy reductions of replacement of single or double glazing by high efficiency double glazing for all years from 2004 to 2020. The results vary from 12 (2004) to 7 (2020) GJ for the replacement of single glass and from 18 (2004) to 12 (2020) GJ for the replacement of double glass. The latter is higher, because the model results (based on data from subsidies) assume that the area replaced is higher. The calculation of the energy savings in the model and emission reductions is based on the harmonized bottom-up method of the EU for the ESD directive.

$$ER\ glazing = \frac{(24\ X\ 3,6\ X\ DD\ X\ A\ X\ (U\ before - U\ after) X\ d}{1.000.000}\ X\ \frac{1}{\eta}\ X\ EF$$

With:

U_{before}	heat loss coefficient glass before replacement (W/m^{2}K) based on household model output for 1995 and 2007
U_{after}	heat loss coefficient glass after replacement (1,2 W/m^{2}K)
A	average loss area (m^2) (glass area) based on information from grid managers
DD	number of heating degree days (1946)
η	total system efficiency for heating

EF weighted emission factor for the fuel mix of existing houses for heating (in kg/GJ)

d correction factor for temperature reductions during night (86% for 75% of the time)

The specific values in the formula are those of the Flemish household model [16] , and the energy reductions used for the calculation in this study are directly taken from the model. Only the multiplication with the appropriate emission factors was done outside the model, depending the fuel mix in the reference years 1995 or 2007.

The resulting unit CO_2 savings per year are listed in the following table.

Table 11. Unit CO_2 emission reduction for replacement of single or double glass

Unit CO_2 emission reduction per installation	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***2010 -2020***
CO_2 reduction (kg)- single glass	741	648	695	695	461	434	477
CO_2 reduction (kg)- double glass	1.123	1.123	1.158	1.251	776	674	789

Since we do not know which % of the replacements is for single glass or double glass, we have calculated an average unit CO_2 reduction, with a uniform distribution between 0 and 100% of both. We also assumed a normal distribution with a 10% standard deviation for the unit savings each year.

The Monte Carlo analysis gave the following CO_2 unit reductions and deviations.

Table 12. Average unit CO_2 emission reduction for replacement of single or double glass

Unit CO_2 emission reduction per installation	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***2010-2020***
Average (kg)	995	945	990	1.036	651	585	667
Standard deviation	142	165	163	190	110	88	109

4.3.5.7 Roof insulation

As for double glazing, Flanders has also calculated (preliminary model results) unit energy reductions of roof insulation for all years from 2004 to 2020.

$$ER\, roof = \frac{(24\, X\, 3{,}6\, X\, DD\, X\, A\, X\, (U\, before - U\, after) X\, d}{1.000.000}\, X\, \frac{1}{\eta}\, X\, EF$$

With:

U_{before}	heat loss coefficient roof before replacement (W/m^2K), 1995 or 2007 based on household model output.
U_{after}	heat loss coefficient roof after replacement (W/m^2K) based on information from grid managers.
A	average loss area (m^2), changes based on information from grid managers
DD	equivalent heating degree days (1946)
η	system efficiency for heating based on household model
EF	EF for different types of heating in existing houses in Belgium (in kg/GJ)
d	correction factor for temperature reductions during night (86% for 75% of the time)

The specific values in the formula are included the Flemish household model [17] , and the energy reductions used for the calculation in this study are directly taken from the model. The results vary from 38 (2004) to 24 (2020) GJ. Only the multiplication with the appropriate emission factors was done outside the model, depending the fuel mix in the reference years 1995 or 2007.

The resulting unit CO_2 savings per year are listed in the following table.

Table 13. Unit CO_2 emission reduction for roof insulation.

Unit CO_2 emission reduction per installation	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***2010- 2020***
CO_2 reduction (kg)	2.507	2.242	2.224	2.174	1.449	1.439	1.517	2.507

We assume for the overall Monte Carlo analysis a normal distribution with a 10% standard deviation for the unit savings each year.

4.3.5.8 Thermostatic valves or time regulated thermostats

The CO_2 reduction of an installation of thermostatic valves or regulated thermostats is calculated as follows:

$$ER\ valves = Q\ X\ \left(\frac{1}{\eta\ before} - \frac{1}{\eta\ after}\right) X\ EF$$

With:

ER_{valves}	unit emission reduction for thermostatic valves (kg)
Q	heat demand based on model results (GJ)

η_{before}	system efficiency heating before replacement (%)
η_{after}	system efficiency heating after replacement (%)
EF	weighted EF for the fuel mix of existing houses in Belgium for heating (kg/GJ)

The heat demand is a calculated result from the Flemish preliminary results (see also condensing boiler). There are 2 baselines for this heat demand: 1995 and 2007. The parameter η (system efficiency) is the combined result of different efficiencies: distribution efficiency, emission efficiency and control efficiency. This last efficiency is changed by introducing thermostatic valves or more regulation.

The reference situation is a non efficient regulation system.

In the following table, the input parameters and their minimum and maximum values are presented. These are based where possible on the same (preliminary) assumptions and model results from the Flemish calculation for the energy efficiency directive. Other assumptions are based on expert judgement or data from literature, and assumed to have a triangular distribution.

Table 14. Assumptions for the calculation of CO_2 unit reduction for thermostatic valves and time regulated thermostats

Input parameter	Min	Mean	Max	Source
Average heat demand 1995 (GJ)	99	119	139	Flemish model
Average heat demand 2007 (GJ)	85	105	125	Flemish model
η_d (distribution efficiency)				
with control	0,86	0,95	1	Estimated
without control	0,86	0,95	1	Estimated
η_e (emission efficiencency)				
with control	0,86	0,95	1	Estimated
without control	0,86	0,95	1	Estimated
η_r (control effciency)				
with control	0,88	0,98	1	Estimated
without control	0,86	0,95	1	Estimated
boiler efficiency				
NG HR+	0,83	0,92	1	Estimated
NG HR top	0,96	1,07	1,1	Estimated
HO optimaz	0,83	0,92	1	Estimated
HO optimaz elite	0,92	1,02	1,1	Estimated
Old	0,73	0,83	0,93	Estimated
% of occurence in houses				
NG HR+		Calculated by difference		
NG HR top	0	20	40	Estimated
HO optimaz	0	20	40	Estimated
HO optimaz elite	0	20	40	Estimated
Old	0	20	40	Estimated

For the **baseline 1995**, the Monte Carlo analysis gave a CO_2 unit reduction of **336 kg CO_2**, with a standard deviation of 784. For **baseline 2007**, the reduction was **279 kg CO_2**, with a standard deviation of 659.

4.3.5.9 Energy audit

No calculations are made here, since the audits give clients information on the measure they can take to reduce their energy use. The impact of the measures itself is included under each of the technologies implemented as a result of the audits.

4.3.5.10 Solar thermal systems

For the Flemish energy, preliminary energy savings per year, per m^2 installed and type of fuel were performed. The results are shown below.

Table 15. Energy savings (in kWh/m^2) for solar thermal systems per m^2 installed

Income year	*Natural gas*	*Heating oil*	*Coal*	*LPG*	*Electricity*	*Wood*	*TOTAL*
2003	218	153	1	2	147	1	532
2004	222	148	1	2	145	1	520
2005	226	143	1	2	142	1	516
2006	225	140	1	2	141	1	511
2007	225	136	1	2	139	1	506
2008	227	132	1	2	137	1	501
2009	230	127	1	2	134	1	496
2010	233	123	1	2	132	1	492
2011	235	120	1	2	130	1	488
2012	238	116	1	2	127	1	485
2013	241	112	1	2	125	1	482
2014	228	108	1	2	129	1	469
2015	229	105	1	2	127	1	465
2016	231	102	1	2	125	1	461
2017	232	99	1	2	124	1	458
2018	233	95	1	2	123	1	455
2019	234	92	1	2	121	1	451
2020	235	90	1	2	120	1	448

The emission reduction is calculated based on the harmonized bottom-up calculation method for the ESD directive.

$$\frac{P}{\eta} \times S \times EF$$

With:

P	average produced annually by solar system (GJ/m^2)
S	average size of solar system (m^2)
η	efficiency to produce warm water (%)
EF	weighted EF depending on fuel type type/technology (kg/GJ)

Values for the reference efficiency to produce warm water are derived from the Flemish household model. A harmonized value for the average production by solar systems was used: 390 kWh/m^2 (1,404 GJ/m^2). If we take into account an average of 4,2 m^2 installed and the appropriate emission factors per fuel type, we can calculate the total CO_2 reduction per installation per year. The results are presented in the following table.

Table 16. Unit CO_2 reduction for solar thermal systems.

Unit CO_2 emission reduction per installation	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
CO_2 reduction (kg)	358	355	353	349	345	342	339	337	334
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
CO_2 reduction (kg)	332	330	316	313	310	308	305	303	301

We assume for the overall Monte Carlo analysis a normal distribution with a 10% standard deviation for the unit savings each year.

4.3.5.11 PV systems

The CO_2 reduction from installing a PV system is calculated with the following formula:

$$S \times P \times EF$$

With:

S	average installation size (kWp)
P	average yearly production (kWh/kWp)
EF	CO_2 emission factor of CCGT power plant (kg/kWh)

As reference the electricity production of a CCGT is considered, since PV electricity will most likely replace this type of electricity production.

In the following table, the input parameters and their minimum and maximum values are presented. The average production has been adjusted to be in line with the data used for the energy efficiency directive. The assumptions are assumed to have a triangular distribution.

Table 17. Assumptions on the input parameters for the calculation of the CO_2 unit reduction for a PV system

Input parameter	Min	Mean	Max	Source
average installation size (households) (kWp)	2	2,5	3	Based on info from [18]
average production (kWh/kWp,y)	750	850	950	See ESD
Emission factor (kg/kWh)	0,34	0,38	0,42	Estimated

The Monte Carlo analysis gave a CO_2 unit reduction of **809 kg CO_2**, with a standard deviation of 83.

4.3.5.12 Passive houses

The CO_2 reduction from a passive house is calculated with the following formula:

$$E_{new} \times EF_{new} - E_{passive} \times EF_{passive}$$

With:

E_{new}	Primary energy need of a new house
$E_{passive}$	Primary energy need of a passive house
EF_{new}	Average emission factor based on the fuel mix from NIS
$EF_{passive}$	Emission factor based on CCGT

The reference is a new house instead of a passive new house. The energy carrier mix for heating in new houses was taken from building statistics of Statistics Belgium. It was assumed the passive house needs no extra heating, only passive heating. Ventilation requires a certain amount of electricity. The EF for this electricity is the EF for a CCGT unit.

In the following table, the input parameters and their minimum and maximum values are presented. These are mostly based on expert judgement or data from literature, and assumed to have a triangular distribution.

Table 18. Assumptions for the calculation of the unit CO_2 reduction for passive houses.

Input parameter	Min	Mean	Max	Source
energy need passive house (kWh/m^2)	10	15	20	Based on [19]
energy need new housing (present state) (kWh/m^2)	100	105	140	
average m^2 (new houses)	83	103,6	123	Based on [20]
efficiency η30%	0,85	0,94	1	Estimated
% occurrence new housing (energy carrier heating)				
natural gas		Calculated by difference		
heating oil	0	2,1	4,0	
coal	0	0,0	5,0	
electricity	0	2,5	5,0	
other	0	1,1	3,0	
EF electricity production (kg CO_2/kWh)	0,34	0,38	0,42	CCGT

The Monte Carlo analysis gave a CO_2 unit reduction of **2.415 kg CO_2**, with a standard deviation of 304.

4.3.5.13 Floor insulation

The CO_2 reduction from floor insulation is calculated with the following formula:

$$ER\ floor = \frac{(24\ X\ 3{,}6\ X\ DD\ X\ A\ X\ \ x\ aj\ X(U\ before - U\ after)X\ d}{1.000.000}\ X\ \frac{1}{\eta}\ X\ EF$$

With:

DD	number of heating degree days
aj	0,33, see K level calculation (floor)
η	system efficiency heating (%)
U_{before}	heat loss coefficient floor baseline (W/Km^2)
U_{after}	heat loss coefficient floor with measure (W/Km^2)
d	lowered heat demand correction factor (86%, implemented for 75%)
A	surface area (m^2)
EF	weighted emission factor (kg/GJ)

The unit savings have to be calculated for baselines 1995 and 2007. The only parameter we change is the system efficiency.

In the following table, the input parameters and their minimum and maximum value are presented. These are mostly based on expert judgement or data from literature, and assumed to have a triangular distribution.

Table 19. Assumptions for the calculation of the unit CO_2 reduction for floor insulation.

Input parameter	Min	Mean	Max	Source
efficiency η30% - baseline 1995	0,59	0,65	0,72	See condensing boiler 50% HO and 50% NG
efficiency η30% - baseline 2007	0,67	0,74	0,81	id
U before (W/Km2)	2	2,15	2,3	Estimate
U after (W/Km2)	0,65	0,75	0,85	Estimate
Average loss area (m2)	60	73,7	85	Estimate
% occurrence housing (energy carrier heating)				
natural gas		Calculated by difference		
heating oil	35	43	50	
coal	1	2,8	4	
electricity	5	7,2	10	
other	0	3,0	6	

The Monte Carlo analysis gave a CO_2 unit reduction of **202 kg CO_2** for **baseline 1995**, with a standard deviation of 20. For the **baseline 2007**, the reduction was **177 kg CO_2**, with deviation 18.

4.3.5.14 Wall insulation

As for double glazing and roof insulation, Flanders has also calculated unit energy reductions of wall insulation for all years from 2004 to 2020. The methodology is based on harmonized bottom-up method proposed by the EU for the ESD directive.

$$ER\ wall = \frac{(24\ X\ 3{,}6\ X\ DD\ X\ A\ X\ (U\ before - U\ after) X\ d}{1.000.000}\ X\ \frac{1}{\eta}\ X\ EF$$

With:

U_{before}	Heat loss coefficient wall before replacement (W/m^2K), 1995 or 2007 based on household model output.
U_{after}	Heat loss coefficient wall after replacement (W/m^2K) based on information from grid managers.
A	Average loss area (m^2), changes based on information from grid managers
DD	Number of heating degree days (1946)
d	Correction factor for temperature reductions during night (86% for 75% of the time)
η	System efficiency for heating based on household model
EF	EF for different types of heating m (in kg/GJ)

The specific values in the formula are those of the Flemish household model [14], and the energy reductions used for the calculation in this study are directly taken from the model. The results vary from 33 (2004) to 32 (2020) GJ. Only the multiplication with the appropriate emission factors was done outside the model, depending the fuel mix in the reference years 1995 or 2007.

The resulting unit CO_2 savings per year are listed in the following table.

Table 20. Unit CO_2 reduction for wall insulation

Unit CO_2 emission reduction per installation	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010- 2020*
CO_2 reduction (kg)	2.070	2.144	3.027	2.133	1.872	1.813	2.079

We assume for the overall Monte Carlo analysis a normal distribution with a 10% standard deviation for the unit savings each year.

4.3.5.15 Allocation to Federal PAM

Since there is a significant overlap with regional grants (*e.g.* for condensing boilers) and green certificates (for photovoltaic panels), an allocation between federal and regional measures is in order. As explained in section 2.5.1, the allocation of emission reductions is based on the size of the various types of financial support for the PAM (tax deductions, grants, green certificates for photovoltaic panels). Also for the years 2009-2011, an extra allocation to the federal level is taken into account due to the green loans. The allocation does not take into account the efforts made on promoting, awareness raising, etc. (information on spent budgets was asked for, but has not been received so far).

For some years, data are missing and estimates were made.

In the next table, the allocation of the reduction to the federal PAMs is given.

Table 21. Estimate for allocating reductions to federal PAM

Income year	*Condensing boiler*	*Heat pump*	*Double glazing*	*Roof insulation*	*Thermostatic vavles*	*EAP*	*Solar boiler*	*PV panels*	*Passive house*	*Floor insulation*	*Wall insulation*
2004	0,88	0,30	0,73	0,89	1,00	0,00	0,81	0,04	0,00	0,00	0,00
2005	0,88	1,00	0,91	0,94	1,00	0,00	1,00	0,04	0,00	0,00	0,00
2006	0,86	0,83	0,65	0,76	0,65	0,00	0,87	0,09	0,00	0,00	0,00
2007	0,91	0,92	0,72	0,84	0,69	0,00	1,00	0,17	0,00	0,00	0,00
2008	0,94	0,82	0,86	0,84	0,88	0,00	0,75	0,23	1,00	0,00	0,00
2009	0,94	0,83	0,87	0,84	0,88	0,00	0,75	0,25	1,00	1,00	1,00
2010	0,93	0,71	0,61	0,78	0,98	0,00	0,75	0,25	0,49	0,80	0,58
2011	0,93	0,71	0,61	0,78	0,98	0,00	0,75	0,25	0,49	0,00	0,00
2012	0,93	0,71	0,61	0,78	0,98	0,00	0,75	0,25	0,49	0,00	0,00
2013	0,93	0,71	0,61	0,78	0,98	0,00	0,75	0,25	0,49	0,00	0,00
2014	0,93	0,71	0,61	0,78	0,98	0,00	0,75	0,25	0,49	0,00	0,00
2015	0,93	0,71	0,61	0,78	0,98	0,00	0,75	0,25	0,49	0,00	0,00
2016	0,93	0,71	0,61	0,78	0,98	0,00	0,75	0,25	0,49	0,00	0,00
2017	0,93	0,71	0,61	0,78	0,98	0,00	0,75	0,25	0,49	0,00	0,00
2018	0,93	0,71	0,61	0,78	0,98	0,00	0,75	0,25	0,49	0,00	0,00
2019	0,93	0,71	0,61	0,78	0,98	0,00	0,75	0,25	0,49	0,00	0,00
2020	0,93	0,71	0,61	0,78	0,98	0,00	0,75	0,25	0,49	0,00	0,00

Since this allocation was based on a limited number of data, the uncertainty margins are large. We presume a triangular distribution, with a minimum of 20% points less or 20% points higher than the most likely value as shown in the previous table (with a maximum of 100% or minimum of 0%). When the most likely allocation is 100% or 0%, a uniform distribution is used between 50% and 100% or 0% and 50%.

4.3.5.16 Overall results

A Monte Carlo analysis was made, with as output the yearly and the yearly cumulative CO_2 reduction from 2004 to 2020.

The 95% confidence interval (mean ± 2 standard deviation for a normal distribution) of the overall calculation is listed in the following tables (for the annual and cumulative reductions).

Table 22. Minimum, maximum and mean reduction of tonnes CO_2, The overall minimum and maximum was calculated in the Monte Carlo simulation (mean ± 2 standard deviation).

	annual reduction of tonnes of CO_2 (ktonnes)			cumulative reduction of tonnes of CO_2 (ktonnes)		
	Min	Mean	Max	Min	Mean	Max
2004	58	116	174	58	116	174
2005	62	122	181	147	238	328
2006	74	149	225	256	387	519
2007	128	224	320	424	612	799
2008	148	245	342	644	856	1.068
2009	233	315	396	937	1.171	1.405
2010	215	293	371	1.208	1.464	1.721
2011	193	276	359	1.447	1.740	2.033
2012	195	285	375	1.684	2.025	2.365
2013	196	285	373	1.917	2.310	2.702
2014	195	285	374	2.145	2.594	3.043
2015	195	285	375	2.371	2.879	3.388
2016	194	284	374	2.594	3.163	3.733
2017	197	285	373	2.818	3.448	4.079
2018	196	284	373	3.039	3.733	4.426
2019	197	285	373	3.262	4.017	4.773
2020	196	285	374	3.481	4.302	5.123

The sensitivity results show that a certain number of input parameters/assumptions are important, especially the assumptions on boiler replacements (unit reduction) and double glazing.

The annual cumulative CO_2 reduction per year in the period 2004-2020 is presented in the following figure.

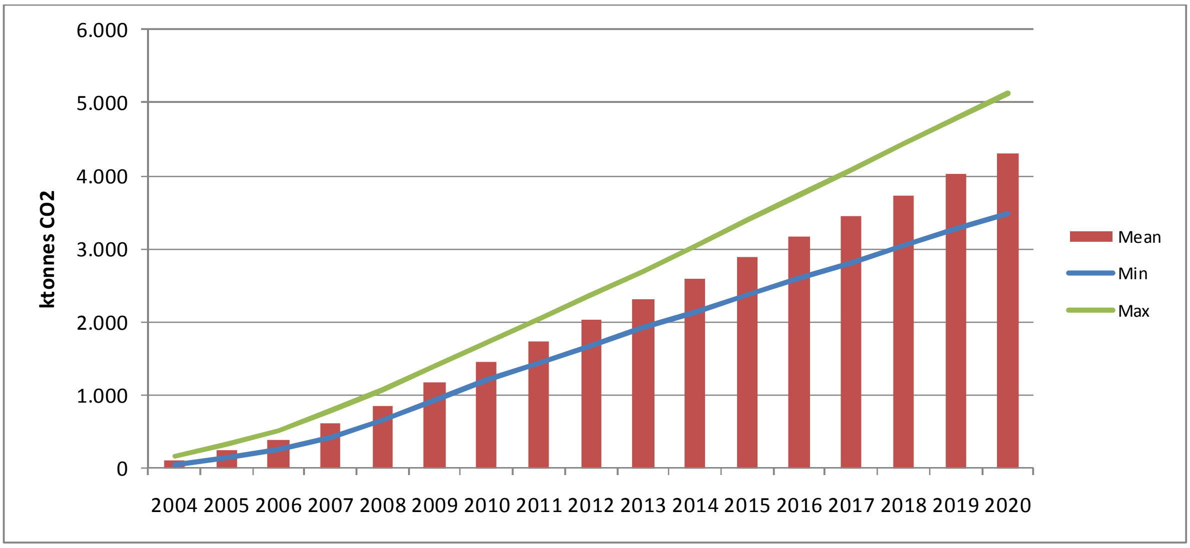

Figure 8. Estimate of the cumulative annual CO_2 reduction for the period 2004-2020.

The annual CO_2 reduction per year in the period 2004-2020 is presented in the following figure.

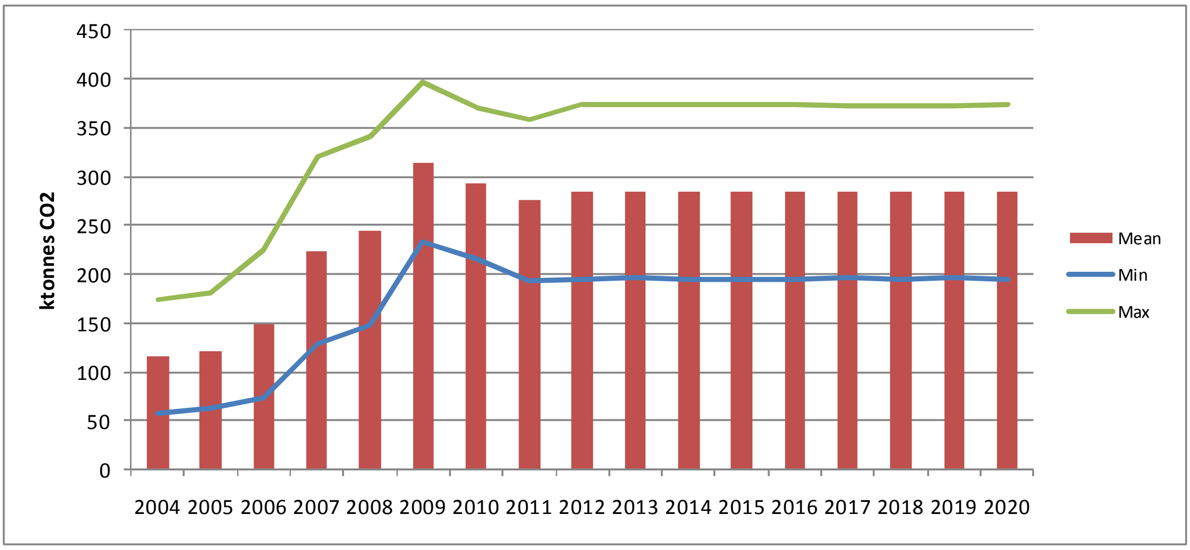

Figure 9. Estimate of the annual CO_2 reduction for the period 2004-2020.

Despite the low number of tax deductions, the reductions achieved in 2004-2007 are still considerable. This is the result of the higher unit savings (baseline 1995) in the years 2004 – 2007 than in the later years (baseline 2007). In 2009 and 2010, the reduction caused by the floor and wall insulations are also visible in the annual results.

To check whether or not the data are realistic in terms of number of equipments installed over the considered period (2004-2020), the cumulative number of techniques for was also analysed as output from the Monte Carlo simulation.

The estimates on the total number of replacements or installations seem reasonable compared to the (estimated) number of Belgian households (we assume a total of approximately 4,95 million households in 2020). A comparison with the statistics from the census 2001 is also possible for insulation: in 2001 2.751.710 households claimed to have double glass; 1.822.391 roof insulation.

Table 23. Overview of the number of techniques/equipments installed over the period 2004- 2020 (Crystal ball simulation).

Technology	***cumulative number 2004-2020***	***number in 2001***	***% of households in 2020 (1)***
Condensing boiler	926.133		18,7
Heat pump	31.527		0,6
Double glazing	2.097.773	2.751.710	98,0
Roof insulation	1.403.189	1.822.391	65,2
Thermostatic valves or time regulated thermostats	544.179		11,0
Solar thermal systems	130.575		2,6
PV systems	439.762		8,9
Passive houses	15.650		0,3
Floor insulation (2)	*3.089*		0,1
Wall insulation (2)	*27.793*	1.203.432	0,6

(1) approximately 4,95 million
(2) only data in 2009 and 2010, so not really comparable to total

The data show that more than 18% of the Belgian households will replace their boilers by a natural gas condensing boiler in the period 2004-2020. 98% of households will have replaced single or double glass in the period 2001-2020. Taking into account the number of houses that already had roof insulation in 2001, the number of houses in 2020 with roof insulation rises to 65%. This is perhaps on the low side: in Flanders, the goal is to have roof insulation in all houses in 2020. The estimates provided here can be considered as conservative estimates.

Conclusions and proposals for improving the estimates

A good monitoring and evaluation (ex post or ex ante) needs good data and methods.

The estimates would be improved if sufficient, detailed data on types of investments would be available:

- The number of tax deductions per technology (and divided between new houses and existing) should be monitored (also if the deductions include more than 1 technology, this should be registered)

- Alternative allocation methods to deal with overlapping measures should be checked and tested

The estimates would also be improved if the unit reduction could be calculated at a more precise level when data are available:

- data on building characteristics are mostly estimates (U values, loss areas, % of energy carriers used, …);
- data on the stock of heating systems in place are also based on estimates and expert judgement;
- baseline assumptions (moving or not , compare to what situation, difference new and existing houses, …).

4.3.6 EC-B02 Standards for wood stoves and coal heating systems

Description

The Federal government has issued a Royal Decree on pollutant emissions (CO and PM) and efficiency for wood stoves and coal heaters[8]. In the NCP, the measure also mentions the definition of quality standards for biofuels for boilers and stoves. These are considered under measure AG-D04.

Assumptions & calculation

In practice the impact of this measure on CO_2 emissions will essentially concern wood stoves. As CO_2 emissions from biomass are not taken into account in the emissions relevant for the Kyoto protocol, the impact of this measure is considered negligible and has not been estimated.

4.3.7 EC-B03 Specific RUE aid for unprivileged people**

Description

Funds are available from FRGE (Fund for the Reduction of the Global cost of Energy) for the energy improvement of housing for disadvantaged people via cheap loans. Funds are available for the energy improvement of housing for disadvantaged people via low interest loans. A total of 50 million € is available for the period 2006-2010, but the fund will potentially be increased up to 250 million € in the near future. Funds are distributed via local entities in 7 cities but an increase is expected to 20 cities in the coming 2 years [21].

[8] Arrêté royal du 12.10.10 réglementant les exigences minimales de rendement et les niveaux des émissions de polluants des appareils de chauffage alimentés en combustible solide.

Assumptions & calculation

Personal communication with FRGE confirmed that there are a significant number of people that have used a loan from FRGE and who also benefited from a tax reduction. To prevent double counting with measure EC-B01 we only included under the present measure low income households that do not pay taxes and who therefore were not able to profit from a tax deduction. In the Excel sheet, however, the impact of all applicants has also been estimated.

Because non-tax payers still may benefit from regional subsidies, an allocation is necessary between federal and regional PAMs. We have used the methodology and information from EC-B01. To estimate the financial benefit obtained from FRGE, we used the mean loan for each subcategory (insulation, heat and solar) and calculated the difference in total reimbursement between a loan at an interest rate of 2% and one at 6% for a period of 5 years [personal communication with FRGE].

In Flanders there existed a higher grant for non-tax payers than for tax payers. This was installed because non-tax payers could not apply for a tax deduction and therefore had a lower financial incentive than tax payers to improve energy efficiency. This policy however will disappear in 2011, because starting from income year 2010 non-tax payers can get a tax credit comparable to the tax deduction. When this is possible, measure EC-B03 overlaps (presumably completely) with measure EC-B01. For practical reasons, however, we have not taken this increase in applications for a tax deduction into account in our projections for EC-B01. The results obtained can thus be summed to the total, without risk of double counting.

With the information from FRGE, a distinction could be made among all different supported technologies for the years 2008, 2009 and 2010. For the period 2011-2020 we have used a distribution based on the information for non-tax payers of 2008-2010. The distribution differs between non-tax payers and tax payers.

We have used the unit emission reductions of measure EC-B01 in this calculation. This unit emission reduction was multiplied with the number of observed or expected investments. We used three different scenarios with respect to the number of applications in 2011-2020:

- Minimum scenario: assumes a fixed budget of 50 million EUR. This budget will limit the number of applications for non-tax payers to 205 in the period 2012-2020.
- Mean scenario: assumes a budget of 100 million EUR. This will limit the number of applications for non-tax payers to 587 in 2012-2020.
- Maximum scenario: this assumes a final budget for FRGE of 250 million EUR and an increasing share of non-tax payers. In this scenario the number of non-tax payers steadily increases to 2.929 in 2020.

Table 24. Number of loans for non-tax payers in 2008-2010 and distribution among technologies.

	2008	***2009***	***2010***	***2011***	***2012 - 2020***
	#	**#**	**#**	**#**	**%**
solar boiler	0	0	0	6	0
condensing boiler	9	41	62	158	26
condensing pelet boiler	0	0	0	3	0
wall insulation	0	3	9	23	4
floor insulation	0	3	4	6	2
roof insulation	0	29	73	116	21
PV panels	0	0	14	36	4
heat pump	0	1	0	0	0
Thermostats	0	1	3	5	1
glas insulation	9	55	139	240	42

Results

The results for the mean scenario show that a cumulated emission reduction of 41 kton CO_2 can be achieved in the period 2008-2020. In the maximum scenario this amounts to 97 kton CO_2 (Figure 10).

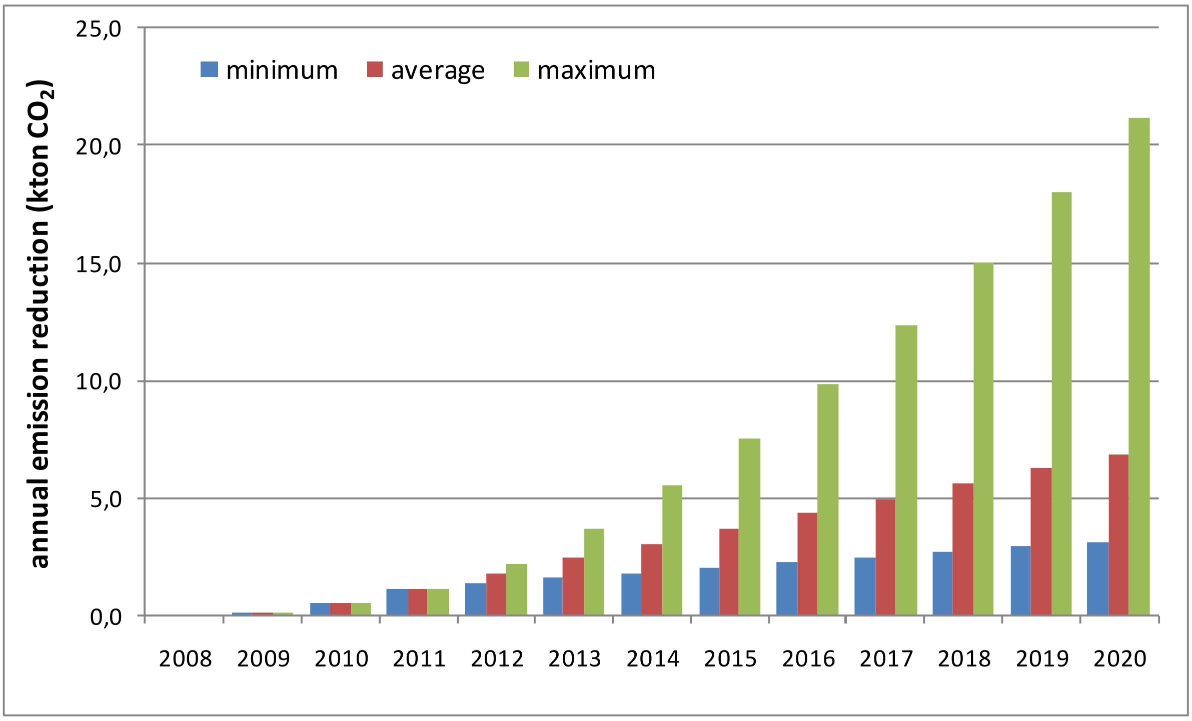

Figure 10. Results for EC-B03 in minimum, mean and maximum scenario.

4.3.8 EC-C01 Third party financing for energy saving investments

Description

To improve energy efficiency in public buildings, the Federal government created in 2005 FEDESCO. FEDESCO is financed by the government and invests in projects to increase energy efficiency via *e.g.* energy performance contracts, energy monitoring systems and PV panels in the 1.800 buildings used by the Federal government.

Assumptions & calculation

Not all investments by FEDESCO are taken into account under this PAM. Only those in energy efficiency are considered and not in PV panels. The latter is included under OB-B01. The NCP mentions an objective of FEDESCO to decrease CO_2 emissions from public buildings with 22% in 2014 compared to 2007. The CO_2 emissions by public buildings have been very roughly estimated at 600.000 tonnes for 2007 [22]. This objective will be achieved via energy performance contracts, energy scans and audits and investments to improve energy efficiency [23]. In 2010 for instance, FEDESCO installed solar reflecting window foils [24].

The budget foreseen in the business plan and actually allocated to FEDESCO is given in Table 25. Although 12,5 million € was available in 2008, there were only projects for a total of 8 million € with public services. Based on the information in Table 17, we assume that FEDESCO has a 30% backlog compared to their objective.

Table 25. Overview of the budget foreseen, the budget allocated and the actual contracts of FEDESCO for 2008-2011.

	Budget foreseen (m€)	***Budget allocated (m€)***	***Actual contracts (m€)***
2008	12,5	12,5	8
2009	17,5	12,5	12,5[a]
2010	30	21	?
2011	59	?	?

[a] estimation based on personal communication with Fedesco.

In the minimum scenario we have assumed that this backlog will imply that the objective of 22% will be achieved in 2017, instead of 2014. In the maximum scenario we have assumed that the objective will be met in 2014.

In the future more detailed information will become available from FEDESCO, which should make it possible to adjust the methodology.

Results

A 22% reduction, implies an estimated 132 kton CO_2 less emitted per year. Depending on when this target will be met the total cumulated emission reduction for the period 2008-2020 ranges between 81 (in 2017) and 89 (in 2017) kton CO_2. We have to underline that this is based on very rough estimates of both the emissions from public buildings and the impact of the activities of FEDESCO (Figure 11).

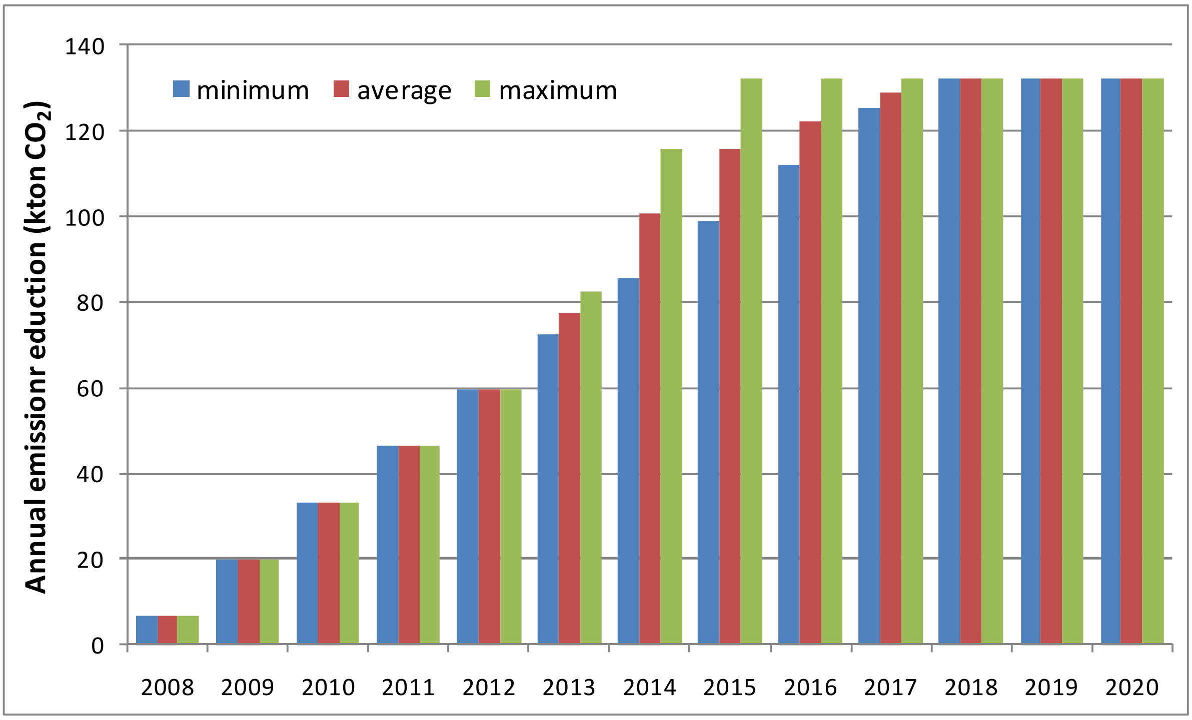

Figure 11. Results for EC-C01 in the minimum, mean and maximum scenario.

4.3.9 IP-A06 Tax deduction for energy saving investments by companies**

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 of 13,5% for energy saving investments by companies (instead of 3,5% for standard investments). For the year 2009 the deduction level has been raised to 15,5% for energy saving investments, while standard investments no longer benefit from a tax deduction.

Assumptions & calculation

Despite the fact that 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 taken into account from 2004 for the calculation of the energy saving is the whole rate, and not only the increase in deduction rate since 2004.

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. So what we have done is only a rough evaluation, only based on the amounts invested.

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

$$Pb\_time = \frac{Investment}{En\_savings * En\_prices} \Leftrightarrow En\_saving = \frac{Investment}{Pb\_time * En\_prices}$$

With:

Pb_time	payback time
En_savings	energy savings
En_price	energy prices

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 is done through the following assumptions:

- all investments with a payback time up to 2 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 increases from 2 years to 2/(1-*td*) years, where *t* 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% from 2009) and that for other investments (3% until 2007, 0% from 2008).

The energy price used is an average, calculated for the average energy carrier mix (Electricity, Fuel oil, Natural Gas) in industry and based on average annual energy prices.

The projection is based on:

- an amount of energy savings investments equal to the average values observed from 2004;
- fuel shares assumed to be constant and equal to the average observed for the years 2004-2009;
- energy prices assumed to be constant from the last year for which data are available (2008);
- the investments are assumed to have a life time of 10 years.

Results

The results in the figure below are given for both ANRED (emission reduction corresponding to the investments of the year) and RED (actual emission reduction of the measure, obtained by cumulating ANRED over the lifetime of the investments).

At the horizon 2020, 247 kton CO_2 are considered as saved from the IP-A06 measure.

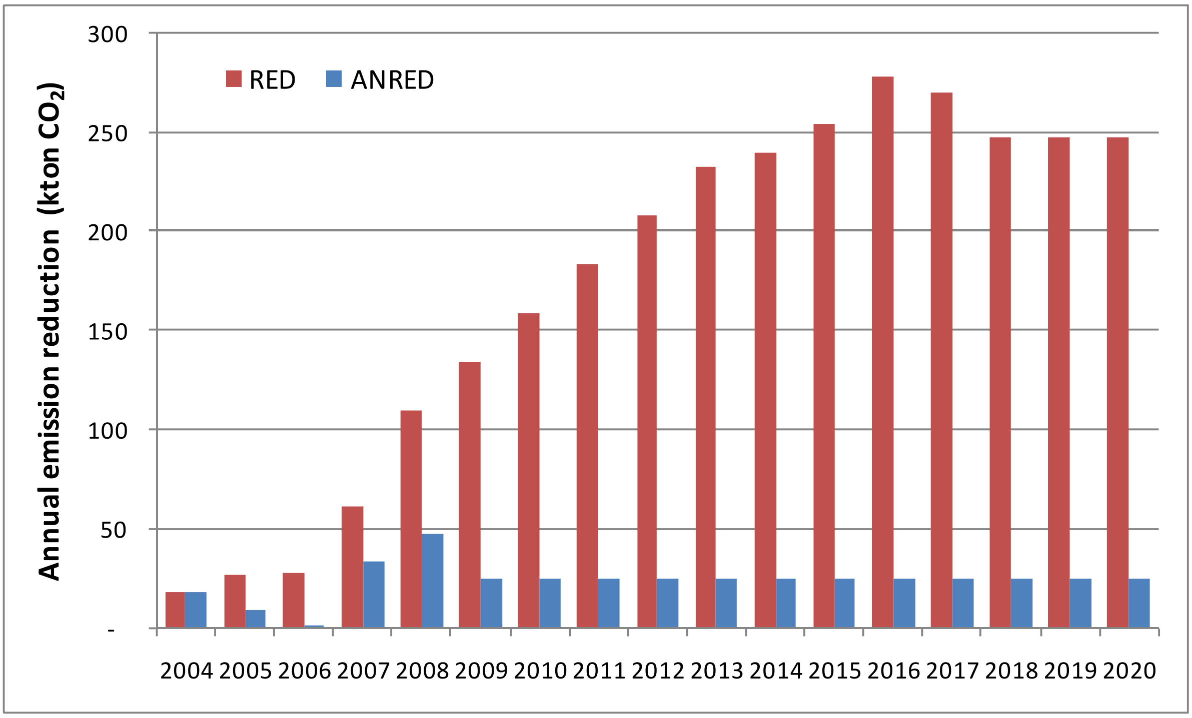

Figure 12. Results for IP-A06.

4.3.10 TR-A01 Mobility plans at local level

Description

The Federal government makes available for companies diagnostic tools that can serve as a basis for setting up company transport plans.

Assumptions & calculation

The impact of this measure, which is the extra emission reduction resulting from the availability of federal diagnostic tools for setting up company transport plans, has not been estimated separately. It is very indirect and at least partially included under the measures to promote public transport (TR-A02), cycling (TR-A02) and carpooling (TR-A03) for commuting.

Results

No specific evaluation has been performed on this measure.

4.3.11 TR-A02 Improvement and promotion of public transport**

Description

Through Royal Decrees of 29 June 2008, the management contracts of the 3 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), 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 travellers), 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.

Assumptions & calculation

For over twenty years, until 1986, the number of train passengers has had a downward trend; after that it stabilised for about ten years and since then it has regularly increased, in particular as a result of the Federal government's policies.

The impact of the measure is considered to correspond to the absolute increase in the number of passenger-km by train since 2004, assuming that:

- the imposed objective will be reached , with a linear interpolation for 2011 and 2012 (2010 has been extrapolated on basis of the results from January 2010 to September 2010, source: SPF economy monthly stat's publication – March 2011);
- for the period 2012-2020 an average annual growth of 2% is assumed in the number of transported passengers, as suggested by FPS Mobility [25];
- the impact corresponds to a modal shift from cars to railway on a one-to-one pkm basis;
- the average number of persons per car replaced by rail way is 1,2 (the average between 1 and 1,4, the latter being the average for the entire car traffic);
- the emission factor of the car replaced is the average emission factor of the car stock (see section 3.2.3);
- for the increased railway traffic (assumed 100% electricity-driven), the emission factor corresponds to that of a CCGT plant (see section 3.2.1);
- the allocation to federal PAMs is 100% (the impact of the contribution of regional governments to the financing of train tickets for regional civil servants is neglected);
- the impact that the promotion of railway passenger traffic has on the development of urban public transport is compensated by the impact of urban transport measures (taken by the Regions) on the railway traffic.

The emission reduction is calculated using the following formula:

$$\left(\frac{EF_{car}}{1,2} - EF_{rail}\right) \times (P_{km} - P_{km\ 2004})$$

With:

P_{km}	Number of passenger-km by train
$P_{km\ 2004}$	Number of passenger-km by train in 2004
EF_{car}	Emission factor car (g/km)
EF_{rail}	Emission factor rail (g/pkm)

Remark: the measure also has a positive impact on traffic congestion, thereby leading to further emission reductions. This second order effect has not been taken into account.

Results

The results are expressed as annual reduction impact.

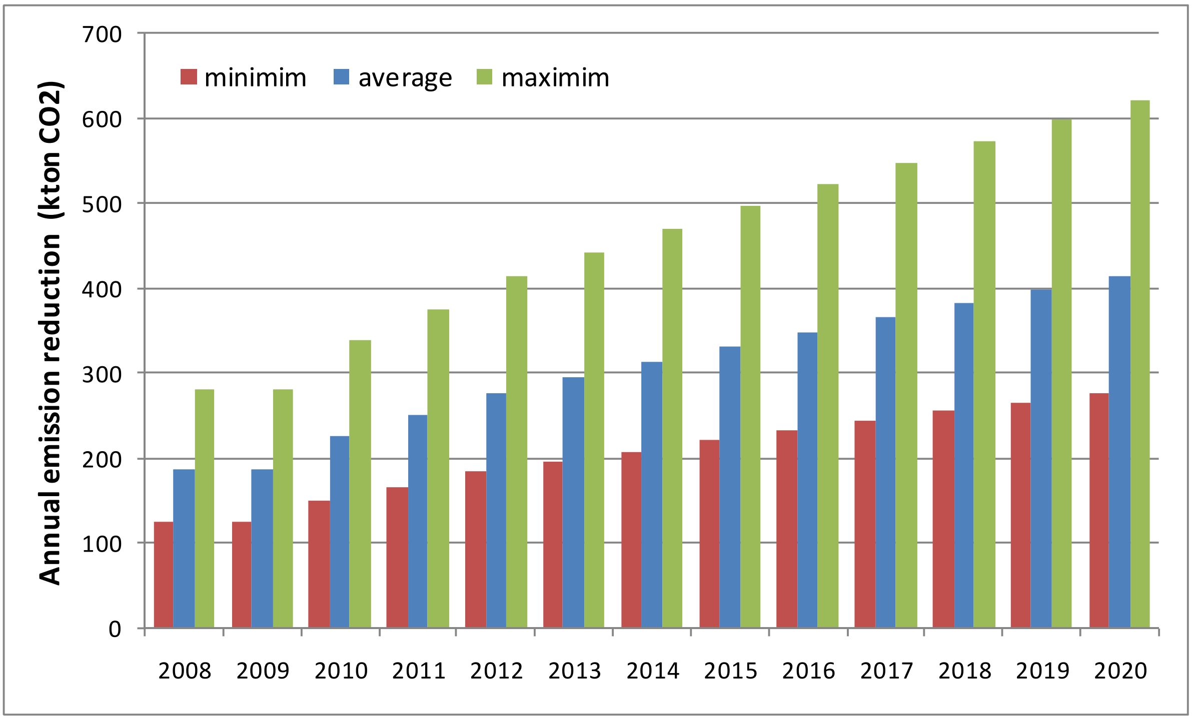

Figure 13. Results for TR-A02.

4.3.12 TR-A03 Promoting bicycle use

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);
- 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). This rate has been raised up to 0,20€/km from 2009;
- in 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 78 000 parking spaces for bicycles in stations, compared with 59 000 in 2008.

Assumptions & calculation

The impact of the measure is considered to be the overall emission reduction resulting from the absolute increase in bicycle use for home-work travel observed between 2005 and 2008 in the survey on home-work travel of FPS Mobility, assuming that this increase is due to a modal shift from car to bicycle. This annual growth is applied until end of 2011.

For the period 2012-2020, it is assumed that the number of passenger-km by bicycle for home-work trips will remain stable (at its value of 2011).

It is assumed that bicycle mobility replaces car mobility in an average car of the car stock, with on average 1,2 persons per car (as for measure TR-A02). Note that this impact includes the impact of measure OB-C03.

The emission reduction is calculated using the following formula:

$$\left(\frac{EF_{car}}{1{,}2}\right) \times (P_{km} - P_{km\ 2004})$$

With:

P_{km}	Number of passenger-km by bicycle for home-work travel
EF_{car}	Emission factor car (g/km)

The calculation is based on results of the mobility surveys of FPS Mobility on home-work travel, carried out in 2005 [26] and 2008 [27]. No additional data have been available for the projection to 2020. Note that this survey only provides percentage numbers of travel for each mode, but not the distances achieved. Therefore some results of the latest mobility survey report for Flanders (where the essential part of the cycling takes place), for the year 2000, have also been used. The details are mentioned in the Excel template.

Results

The results are expressed as annual reduction impact.

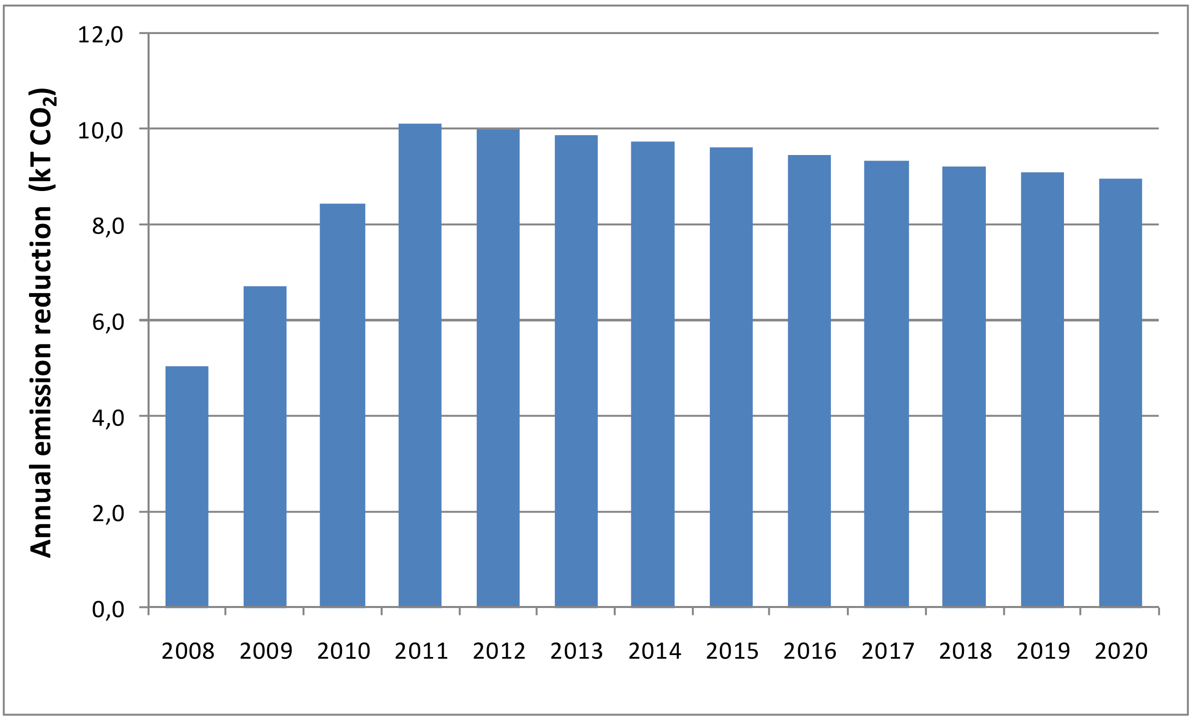

Figure 14. Results for TR-A03.

4.3.13 TR-A04 Promoting multimodal systems for goods

Description

For goods, the development of multimodal platforms occurs through the improvement of river and rail transport (logistics area, infrastructure, investment...). The Federal government supports the NAIADES programme (2006-2013) of the European Commission to promote inland navigation. This includes fiscal support for the modernisation 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 30.9.05, later extended to end 2008). This has been extended from the 01/01/2009 (Programme-Law of 22.12.08, chapter 3: end of application 01/01/2013). The aim was to help maintain the existing rail traffic level and to increase it by 20% over a period of three years.

Assumptions & calculation

As baseline, it has been assumed that without subsidies the remaining traffic would disappear, except for the traffic between Antwerp and Zeebrugge (where the volumes are large) and to and from Athus (where the distances are large), which respectively represented 57% and 12% of the total internal intermodal transport in 2007.

The actual impact of the measure should be evaluated by comparing the emission level with that of the baseline for the same year, *i.e.* the emission level that would have taken place in the absence of the subsidies. Assuming that without subsidies the remaining traffic would disappear, we consider as baseline for 2008 a number of ITU[9] equal to 396.000 * 69% = 273.000.

Emission reductions from modal shift to inland navigation have not been quantified, as the impact of the measure is only indirect, not easy to evaluate and expected to be marginal.

For the modal shift to rail transport, the emission reduction has been evaluated based on the difference between the projected evolution and the baseline (stabilisation of the number of ITUs transported – value of 2008), with an average trip of 150km and an average charge of 17T by ITU.

For the evolution from 2011 to 2020 to an annual growth of number of ITUs of 6% has been assumed, based on information from FPS Mobility [28].

The emission reduction is expressed as follows:

$$\Delta ITU \times t \times d_{av} \times \Delta EF_{av}$$

With:

ITU	Increase in number of ITUs,
t	Average number of tonnes transported by ITU [t];
d_{av}	Average distance per trip [km];
EF_{av}	Difference in emission factor between transport by train and by road;

Results

The results are expressed as annual reduction impact:

[9] Intermodal Transport Unit.

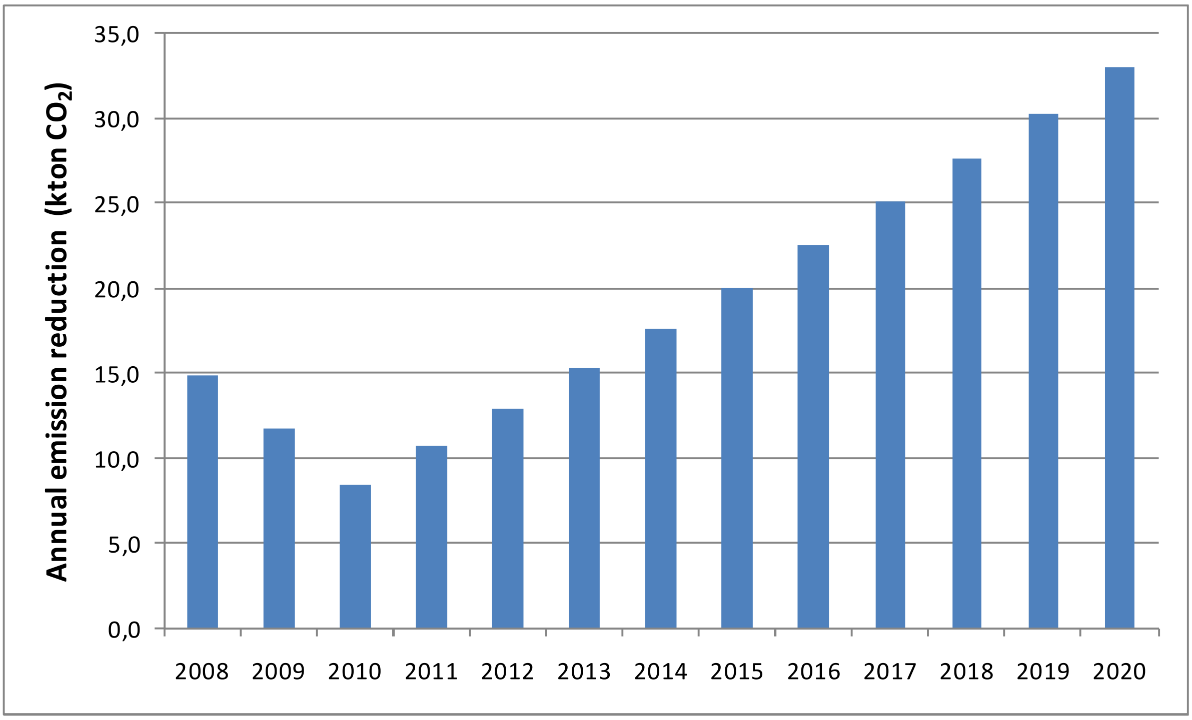

Figure 15. Results for TR-A04.

4.3.14 TR-A08 Free public transport for commuters

Description

The federal and regional policies 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, etc… 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 until 2012. In this system, 80% of the season ticket of the 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 also been extended until 2012

Assumptions & calculation

The impact of this measure is included under measure TR-A02.

4.3.15 TR-B01 Promotion of car-pooling

Description

Carpooling is supported fiscally. Home-work travel expenses for using car pooling 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 - update in Art38 from 2008).

Assumptions & calculation

This measure has started from the revenues of 2002. The impact is taken under consideration from 2004.

The data are available for 2005 and 2008, the previous and followed years have been extrapolated from these. The impact is evaluated considering the number of person-km by car avoided thanks to car pooling, with an average number of people by car for car pooling of 2, and a occurrence of carpooling limited to 3 days/week.

The global evolution of the number of workers has been assumed equal to the one observed during the period 2005-2008 (out of crisis period).
The emission reduction is expressed as follows:

$$\mathrm{KMcp} \times \Delta\mathrm{EF}$$

with:

ΔEF	decrease in emission factor due to use of carpooling [g/km];
KMcp	distance per year per carpooler [km].

Results

The impact of this measure is relatively stable. The results are expressed as annual reduction impact:

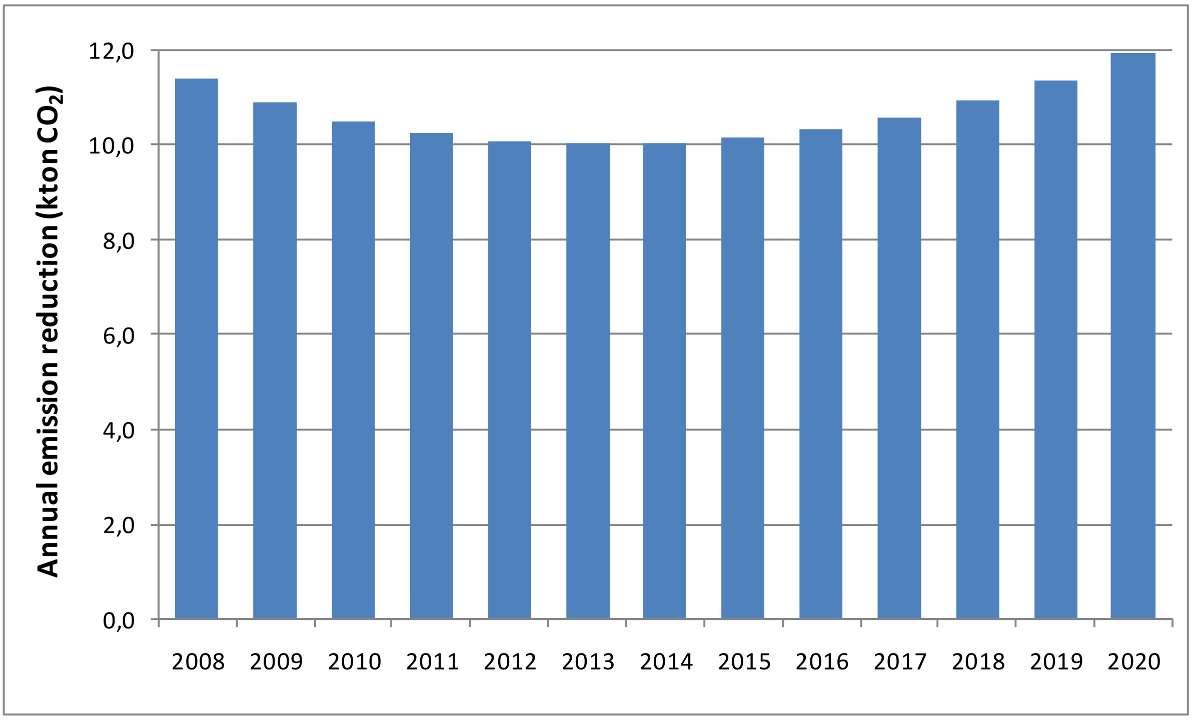

Figure 16. Results for TR-B01.

4.3.16 TR-B03 Promotion of teleworking

Description

At the request of the Flemish region a consultation with federal authorities through an interministerial committee has been planned in order to examine possible tax incentives for teleworking systems.

Assumptions & calculation

The impact is considered to be negligible, as there is no concrete decision on implementation at this stage.
Remarks:

- This measure does not cover measure OB-C04, which is also on teleworking, but focused of servile servants.
- some doubts have been raised about the actual level of energy savings achieved through teleworking, as the saving on transportation fuels is to a certain extent compensated by an increased energy consumption for space heating, when the office remains heated. The main advantages of teleworking seem to lie in a reduction of traffic congestion and an improvement of comfort for the teleworkers.

4.3.17 TR-B05 Eco-driving

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 licence 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 the optimisation of fuel consumption in the list of subjects of the qualification tests and periodic training for the Certificate of Professional Competence (CPC).

Actions are also foreseen for the general public (*e.g.* inclusion of a module on eco-driving in the programmes of driving schools), specific target groups (such as sales representatives) and public authorities (*e.g.* training of town personnel).

Assumptions & calculation

According to Bond Beter Leefmilieu, eco-driving allows fuel savings of 5 to 7% for heavy duty vehicles [www.bondbeterleefmilieu.be/eco-driving/page.php/293]. However, the level of saving depends very much on the traffic circumstances (the value has been assumed to 5,8% for the evaluation).

The content of directive 2003/59 is in force in Belgium for category D licences since 10 September 2008 and for category C licences since 10 September 2009.

Seven years after these dates of entry into force, all drivers of each of both categories will have had an initial qualification or at least one periodic training. In 2012, this will concern about 40% of the drivers.

The global impact of this measure at the 2020 horizon is calculated as follows:

- In 2012, it will concern about 40% of the drivers. (→*x0,4*)
- In Belgium, 60% of the truck traffic (in vehicle-km) is on motorways, where the vehicle speed is mostly constant and regulated by a cruise-control system and where the savings are therefore likely to be very small, (→*x0,4*)
- Part of the drivers would already apply eco-driving in the baseline, eco-driving is not a compulsory subject of the periodic training, this periodic training is not subject to a test, drivers do not necessarily apply eco-driving when they have the appropriate qualification, a substantial part of the heavy duty vehicle traffic is generated by foreign drivers, who are not concerned by the (Belgian federal) measure,(→*x0,7*)

The emission reduction has been calculated as follows:

$$C \times EF_g \times EMRR$$

With:

EF_g	Emission factor for the gasoil
C	Energy consumption of diesel fuel for heavy duty vehicles
EMRR	Emission reduction rate

An order of magnitude of EMRR for 2020 is 0,65% (from 0.4*0.4*0.7*0.058). Between 2008 and 2020 this value is linearly interpolated.

For the previous years the values were obtained by a linear interpolation between 0 in 2008 and that value for 2012.

Results

The results are expressed as annual reduction impact:

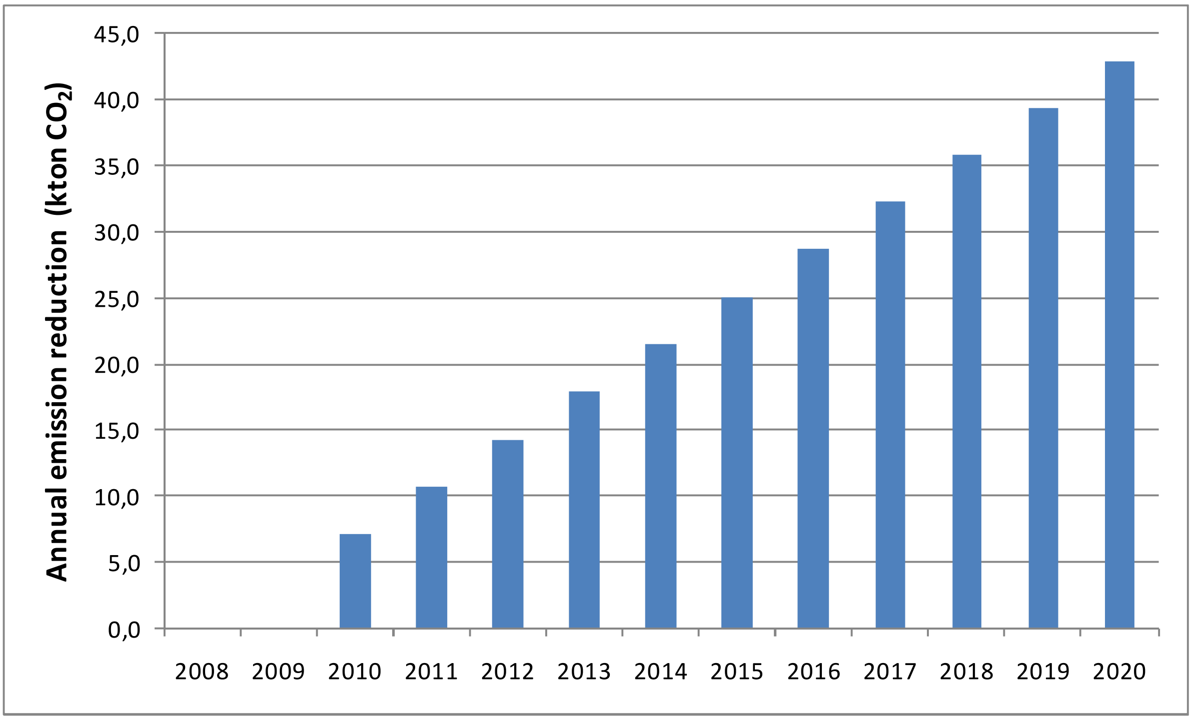

Figure 17. Results for TR-B05.

4.3.18 TR-C01 Tax reduction on the purchase of clean vehicles**

Description

This measure comprises the following elements:

Company cars

- Since 1 January 2005, the "solidarity contribution" (a contribution paid by employers who provide a company car) is calculated based on CO2 emissions.
- For company cars purchased since 1 January 2007, the deduction for the corporate tax of all expenses (except fuel) is between 60 - 90% depending on CO_2 emissions.

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.
- Since July 2007, 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.

Assumptions & calculation

Only the impact of the tax reduction and the invoice discount for the purchase of low CO_2 emission cars below 115 g/km has been quantified, under the following assumptions:

- without the measure, buyers would have bought the same category of car;
- the tax reduction/invoice discount does not accelerate the purchase of new cars;
- the free rider effect is taken into account by computing a baseline with a specific number of car registrations by vehicle category:
  - for the vehicles "105-115 gCO_2/km" (called 'middle level' in formula), the number of new car registrations is equal to the number of new vehicles of this category before the implementation of the PAM;
  - for the vehicles "< 105 gCO_2/km" (called 'low level' in formula), the number of new car registrations is increasing to be consistent with the evolution of new car market which has exploded for the last years. For example: in 2007, the CO_2 guide references 6 vehicles <105 gCO_2/km, in 2010; 37 models are referenced;
- in the future and up to the end of 2012, the number of new cars benefiting from an invoice discount will continue at the same rate as over the last twelve months;
- the impact of the Ecobonus in Wallonia (bonus/malus system for the purchase or replacement of more environmentally friendly vehicles, entered into force on 1 January 2008) has been deducted from the emission reduction. The Walloon measure has been deeply reviewed from September 2010, with a reduction of the subsidies. The resulting impact on new cars after this date is considered as negligible (although there is no data to confirm this).

From 2013 to 2020, it has been assumed that:

- A change in the emission reduction levels will be applied, for this evaluation we propose to consider <u>a reduction of 15 gCO_2/km</u>, that means:
  - 3% of tax reduction for vehicle with emission between 90 gCO_2/km and 100 gCO_2/km as 'middle level' criteria;
  - 15% of tax reduction for vehicle with emission below 90 gCO_2/km as 'low level' criteria;
- The baseline will be built considering the same levels.

For each category of clean car, the annual emission reduction is calculated using the following formula:

$$(N - N_b) \times (EF_b - EF) \times d$$

With:

N	Cumulative number of cars with tax reduction or invoice discount (on the life time)
N_b	Cumulative number of cars of clean cars in baseline (on the life time)
EF_b	Average emission factor of baseline (g/km) (emission factor of average new vehicle in absence of support)
EF	Average emission factor of clean car (g/km)
d	Average number of kilometres driven per year

note: the life time of the vehicle is estimated to 5 years (EU Directive Car lifetime: 100.000 km).

The Income Tax Code 92 (Art. 145/28) allows a 30% tax deduction for the electric vehicle purchase and battery recharge installation, for the purchases in 2010 to 2012. At the review of this report, it is not possible to evaluate the impact of this measure because no data are available for the ex post evaluation and it is supposed as negligible because of the 2010-limited electric vehicle market. For the ex ante evaluation it depends on a possible prolongation of the PAM and the level of this prolongation.

Results

The results are expressed as annual reduction impact.

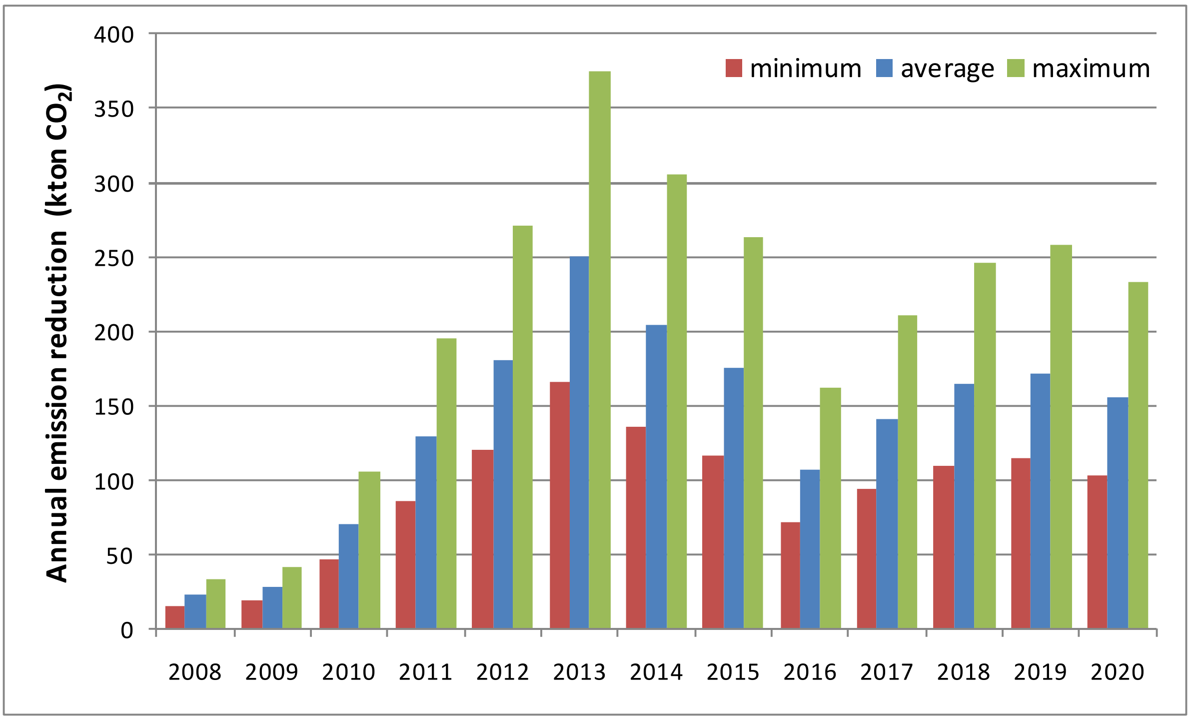

Figure 18. Results for TR-C01.

4.3.19 TR-C02 Promoting the purchase of clean vehicles

Description

Advertisements must mention fuel consumption and CO_2 emissions. The Federal government takes the necessary actions to implement the Royal Decree of 5/9/2001, which describes the correct representation of fuel usage and CO_2 emissions in advertisements. The annual publication "Guide CO_2 de la voiture"/ "CO_2-gids van de auto" provides objective information and allows comparisons among all car models available on the Belgian market with respect to CO_2 emissions, fuel type and consumption and possible tax advantages.

Assumptions & calculation

The impact of this measure is assumed to be included under that of measure TR-C01.

4.3.20 TR-D01 Promotion of biofuels**

Description

The objective of this measure is to ensure a minimum amount of biofuels on the Belgian market (an objective of 5,75%, in terms of energy content, on 31 December 2010 is required by directive 2003/30/EC). The Federal government has decided a tax exemption for certain amounts of bioethanol and biodiesel, to be mixed with fossil fuels. Since 10 March 2006, pure vegetable or plant oil are also free of taxes. Pure rapeseed oil has a tax exemption, but only if the producer sells directly to the end user or when rapeseed oil is used for vehicles in public transport. E85 biofuel (85% bioethanol and 15% fossil fuels), which is not regulated, can be used via a separate distribution network only accessible to end users explicitly involved in a specific project.

In the National Climate Plan, this measure is entitled 'Detaxation of biofuels'. However, as the tax exemptions did not produce satisfactory results, the Federal government has decided to regulate. This was done through the Law of 22 July 2009, which requires petroleum companies to mix 4% by volume (equivalent, by energy content, to 2,6% ethanol in gasoline or 3,7% biodiesel in diesel fuel) of biofuel in the road transport fuels put on the market from 1 July 2009. This obligation is limited to 30 June 2011, with a possibility of 2 year extension, *i.e.* until 30 June 2013. As decided by the steering group, we have included this new decision in this PAM.

European directive 2009/28/EC requires that in 2020 the share of renewable sources (including biofuels) be at least 10% of the final consumption of energy in transport.

The production of biofuel is subject to specifications, defined in the law of 10 June 2006 on biofuels, which sets environmental criteria (energy efficiency, greenhouse gas balances), agriculture (use of pesticides and fertilizers), proximity (shortest distance between production biomass and production unit), etc. (see AG-D04).

Assumptions & calculation

The figures are derived from:

- the situation observed from 2008 to 2010;
- the fuel consumption are kept at the level of 2010 for the period 2011-2020;

- the biofuel part is considered at 4% in volume:
    - In high scenario: until 2020;
    - In low scenario: until the 30/06/2013 (as mentioned in law of 22 July 2009);
- no impact on emissions from the production of biofuels is taken into.

The annual emission reduction per category of clean car is calculated using the following formula:

$$C_g \times EF_g \times b_g + C_d \times EF_d \times b_d$$

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 d (to 2020) iesel oil (kt/PJ)
b_g	Biofuel content of Gasoline
b_d	Biofuel content of Diesel oil

The entire penetration of biofuels is ascribed to this measure. The baseline is no biofuel content. The impact on emissions from the production of biofuels is not taken into account (note that the biofuels may be imported, in which case these emissions are not to be taken into account for the Kyoto protocol).

As decided by the steering group, the upper bound assumes that the obligation imposed by the law of 22 July 2009 will be extended up to 2020, and the lower bound that the incorporation of biofuel will be stopped after the limit of 30 June 2013.

Results

In the maximum scenario, this measure resulted in an annual emission reduction of 895 kton CO_2 from 2010 until 2020.

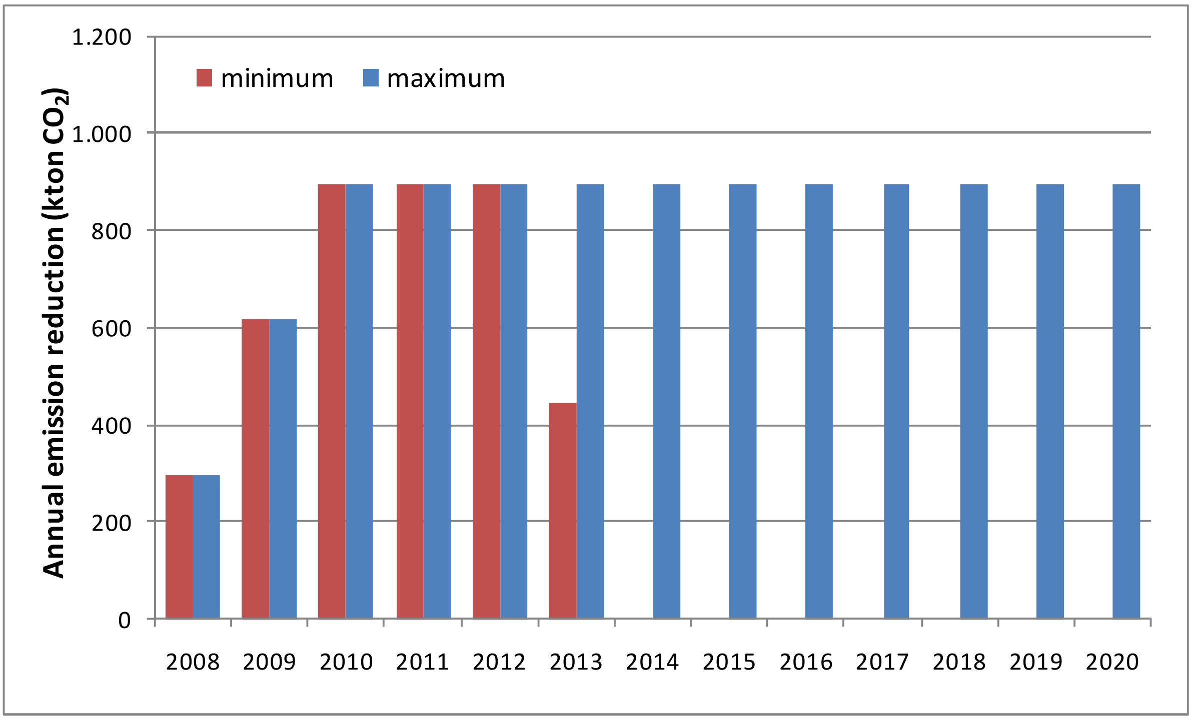

Figure 19. Results for TR-C02 in minimum and maximum scenario.

4.3.21 AG-C02 Preservation of the ecological stability of forests

Description

On 18 November 2005, the Federal government agreed on a circular letter regarding sustainable wood [29]. This circular letter obliges the Federal government to purchase only certified wood from March 2006 onwards. FSC, PEFC and other equivalent certifications are considered suitable. The Federal government has decided on several actions to prevent the import and sales in illegal wood and to increase the control and penalization of this trade. This was done by activating a new contact group FLEGT and structural cooperation between Federal administrations of Environment and Finance. The implementation of these policies results in the preservation of land, limiting changes in land use and consequently the loss of soil carbon. Monitoring is provided by including wood certification criteria of sustainability.

Assumptions & calculation

There are no quantitative data available on the amount of certified wood purchased by the Federal government. However, as the wood concerned by this certification would essentially come from abroad, the impact of this measure on emission reductions relevant for the Kyoto protocol in Belgium has been considered as negligible.

4.3.22 AG-D04 Quality standard for solid biofuels

Description

The demand for solid biofuels has increased steadily. However, the low quality of solid biofuels reduces the efficiency of biomass boilers. The Federal government has decided to prepare a Royal Decree on the quality standards of pellets for biomass boilers. This Royal Decree was issued on 12 October 2010[10] (see also measure EC-B02).

Assumptions & calculation

Emissions from biomass are considered zero in the Kyoto protocol commitments. Therefore the effect of this measure on CO_2 emissions has not been taken into account.

4.3.23 AG-E01 Monitoring of biomass

Description

Different inventory systems are being promoted to better manage the biomass resources in the country. The Federal government, in cooperation with the regions, will establish a national observatory for biomass with the following assignments: collect and/or calculate all useful information on biomass fluxes in Belgium and between Belgium and other countries; harmonise methodologies for collecting information among the different actors in Belgium; draft an annual biomass balance and report possible problems with respect to availability and collection of statistics. This observatory must also determine the suitability of a national biomass strategy.

Assumptions & calculation

Potentially, this measure could have an effect on the emission of greenhouse gases by promoting the use of biomass instead of fossil fuels. However, at this stage this observatory has not yet been established and the impact on biomass use is too speculative to quantify. We conservatively estimate the effect on emission reductions as zero.

4.3.24 WA-A01 Ecotax on non-returnable packaging

Description

In the framework of its policy of environmental taxes (ecotaxes) to discourage the use of disposable packaging and utensils, the Federal government has introduced, from 1 July 2007, a tax on some types of disposable packaging (plastic bags for the transportation of goods purchased in retail stores, plastic and aluminium foils) as well as on disposable table utensils (Programme law of 27 April 2007).

[10] Arrêté royal du 12.10.10 réglementant les exigences minimales de rendement et les niveaux des émissions de polluants des appareils de chauffage alimentés en combustible solide.

Assumptions & calculation

The impact of this PAM, which only concerns a minute fraction of municipal solid waste, on greenhouse gas emissions has been considered as negligible.

4.3.25 SE-A01, SE-A02, SE-A03, SE-A07, SE-A08

Description

The Federal government communicates via brochures and guides, campaigns in media and a website www.klimaat.be / www.climat.be. These communication channels are used to spread information on climate change, situation in Belgium, decisions of Federal government and concrete actions that may interest general public.

Consumers are informed on the CO_2 impact of goods through two important channels: 1) The Federal government publishes annually information on CO_2 emissions, fuel use, … of cars. 2) On the website www.energievreters.be / www.energivores.be the energy consumption and CO_2 emission of electrical appliances and other products (wars, insulation, ...) can be calculated; and a selection is given of the cleanest and most efficient models, based on a set of personal criteria. Building and renovation professionals have access to a portal, hosted by the Federal government, with useful information on legislation, grants, ...

In January 2007, the Federal government and WWF launched the educative project “In de weer voor het klimaat”/ “Le climat, c’est nous“, designed for primary and secondary school teachers and students.

Financial support for local initiatives to increase public participation and awareness on climate change.

In 1999, the Federal government created a specific policy for large cities to develop a harmonised development of cities that contribute to the economic growth of the nation.

Assumptions & calculation

Considerable federal efforts and financial means are given to raise awareness and inform people on climate change and energy savings. It is difficult to assess the impact of these actions. The most important impact these measures will have is that they will stimulate people to invest in energy efficiency, make use of public transport and change their behaviour. Investments in energy efficiency and increased use of public transport are taken into account in the effects of other federal PAMs. Behavioural changes are more difficult to assess and although there are studies currently investigating this, no quantitative data is available yet. Conservatively, the effect of behavioural changes due to horizontal PAMs on emissions has been neglected.

4.3.26 OB-A01 Sustainable public procurement

Description

Via the website http://www.guidedesachatsdurables.be/, the Federal government recommends the purchase of products which are environmentally friendly and produced in socially accepted circumstances.

Assumptions & calculation

For most products, the information provided by the website does not focus on CO_2 emissions, so the relationship with emission reductions is not clear and cannot be quantified. There are three main exceptions: 1) buying green electricity, which is included under the PAMs with EP; 2) buying certified wood products, which is included under AG-CO_2; and 3) buying new vehicles, which is included under OB-C07.

4.3.27 OB-A02 Optimisation of catering on the basis of sustainability criteria

Description

A pilot project to promote sustainable food at a Federal canteen is underway [30]. The aim is to encourage sustainable procurement in this sector too.

Assumptions & calculation

This pilot project is applicable on the federal canteen of the FPS Finance. It focuses on several aspects of sustainable agriculture, of which greenhouse gas emissions is only one aspect. With respect to greenhouse gas emissions, this PAM highlights the importance of food-miles. Considering that emissions from international transport cannot be accounted for in emission reduction reporting, we consider the effect of this PAM as negligible.

4.3.28 OB-A03 EMAS certification**

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 SNCB group of companies foresee the establishment and implementation of an environmental policy plan.

Assumptions & calculation

The annual emission reduction is calculated using the following formula:

$$NP \times \left(\Delta Q \times EF_{heating} + \Delta E \times EF_{electricity}\right)$$

With:

NP	number of civil servants at Federal services with EMAS certification
ΔQ	annual reduction in heating per civil servant
$EF_{heating}$	weighted emission factor for heating
ΔE	annual reduction in electricity consumption
$EF_{electricity}$	emission factor for electricity production, CCGT

Several public services already have an EMAS certification [cfr. 31, 32, 33], representing 9065 employees. In the EMAS reports, the focus is mainly on transport and consumption of energy, water and paper. Increased use of bicycle and public transport for travel to and from work is included under other measures (*e.g.* OB-C03) and therefore not included here. Water and paper consumption have only a marginal and unquantifiable effect on emission reductions. With respect to energy consumption, both electricity and heating, quantitative objectives have been proposed in some cases, which differ considerably among EMAS certified public services, from 2 to 15%. We assume that EMAS certification induces a 5% reduction in energy use per employee compared to baseline consumption, following the objectives proposed by several public services and information provided by PODDO. Importantly, this measure could overlap with measure EC-C01. We therefore have assumed that under this measure only behavioural changes promoting energy efficiency are included, whereas under EC-C01 we only include technical and/or structural changes.

Mean values for energy consumption per full time employee are used (based on information from PODDO). For electricity this is 5.054 kWh/employee (which is higher than in the previous study) and heating 12,9 GJ/employee. In the minimum scenario we only included the FPS that are already EMAS certified (9.056 civil servants) and assumed this would not change until 2020. In the maximum scenario we have assumed that EMAS certification will show a linear increase after 2010, until 30.371 employees.

This measure also includes the energy efficiency improvements the SNCB group has to achieve according to the management contract with the Federal government. This management contract stipulates that a 7,5% reduction of energy consumption (compared to 2005, but excluding energy consumption for locomotives) has to be achieved in 2012 and a 20% reduction in 2020. Information was obtained of the SNCB group on energy consumption for the period 2005-2010. Although energy consumption of SNCB group increased in 2010, this was solely due to the strong weather. When corrected for the number of degree days (taking into account that 80% of energy consumption for heating is temperature dependent), relative emissions were lower than in 2005. We assumed a linear interpolation between the reported consumption and the objectives for 2012 and 2020.

Results

In the minimum scenario, there is an average annual emission reduction of 11,2 kton CO_2. The difference with the maximum scenario is low, with an average annual emission reduction of 12,4 kton CO_2. The reason for this small difference is that the energy savings and emission reductions of the SNCB are considerably larger than the energy savings achieved by the public services (Figure 20).

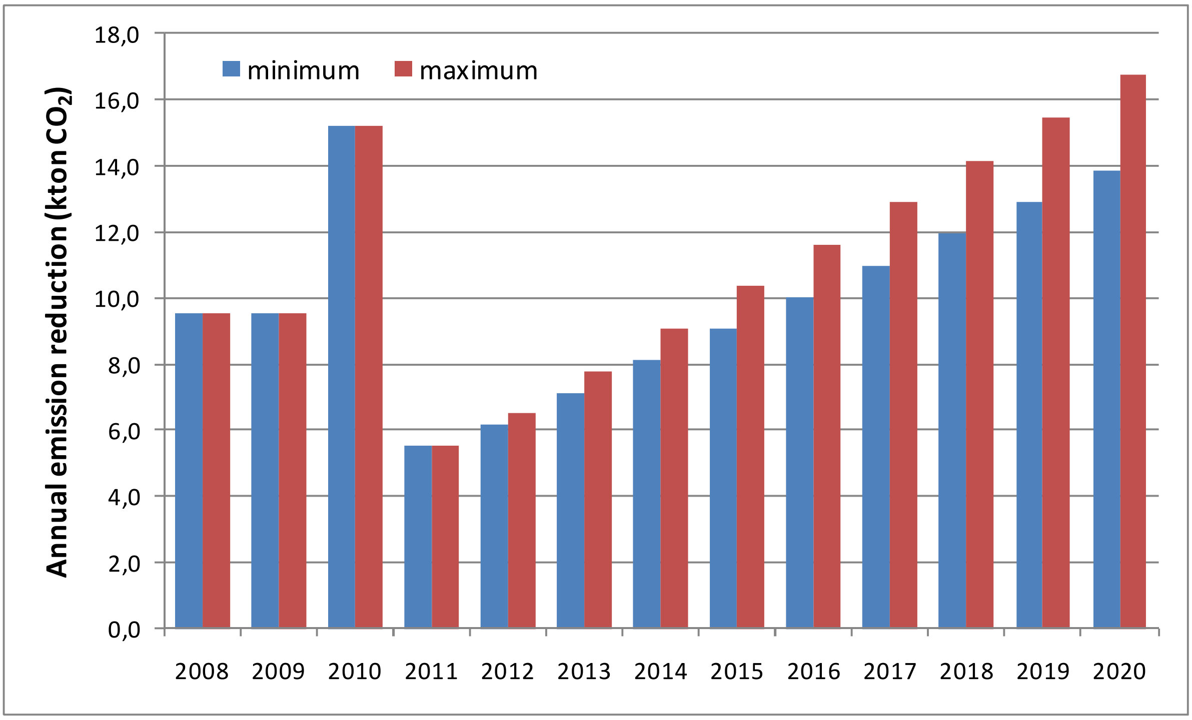

Figure 20. Results for OB-A03 in the minimum and maximum scenario.

4.3.29 OB-B01 Photovoltaic panels on roofs of Federal government buildings**

Description

In March 2007, the Federal government decided an objective of 1 km² of photovoltaic panels on roofs of buildings of the public buildings. This is to be achieved by 3 measures: 1) roofs will be made available for installing PV panels. 2) Installation of PV panels by government, via FEDESCO (2 million € will be invested). 3) the three companies of SNCB group have committed themselves to consider building and installing renewable energy equipment (*e.g.* solar or wind) via partnerships.

Assumptions & calculation

The annual emission reduction is calculated using the following formula:

$$(P_{solar} \times S \times A_{solar} + P_{wind} \times F \times A_{wind}) \times EF$$

With:

P_{solar}	Average annual electricity production with PV panels (kWh/m²)
S	Average installed area (m²)
A_{solar}	Allocation factor (to the federal measure) for PV panels
P_{wind}	Annual electricity production from wind (kW)
F	Average annual equivalent number of full load hours (h)
A_{wind}	Allocation factor for wind turbines
EF	Emission factor of a CCGT power plant (kg/kWh)

For the installed capacity we used information from three actors:

- FEDESCO: We made a distinction between the direct investments of FEDESCO in PV panels (3.200 m² installed by 2011) and the facilitating role FEDESCO plays in setting up concessions. In the latter case, FEDESCO has already assigned a concession of 10.000 m², to be installed by 2012. In the minimum scenario we have assumed that this would be the only investments by FEDESCO, which may be conservative. In the max scenario we have increased the concession to 30.000 m² (to be installed in 2016), as proposed by FEDESCO.
- SNCB: Personal communication with INFRABEL identified different projects on renewable energy. The two most important projects are the PV panels on the roof of the Thalys railway tunnel in Brasschaat (4.095 kWp) and the *wind train* project (a total of 50 MW wind turbines along the railway Louvain-Liège). Most projects are in collaboration with municipalities.

Also in this measure there is a potential overlap with the regional green certificate scheme. It is however more complex, as in this case the Federal government or the SNCB directly invests in renewable energy. Whereas in previous cases we have compared the amount of financial support from the different authorities to determine the allocation factor, this is not possible in this case. We have therefore compared the cost of installation with the amount of financial support from regional authorities (only green certificates, although other incentives might also be possible, such as the Flemish *ecologiepremie*). The Federal government or the SNCB will not in all cases bare the full cost of installation (cfr. Electrabel and the local authorities also collaborate in the wind train project). It is however not possible to determine the actual investment of the Federal government or the SNCB. In case of the concession, the monetary investment made by FEDESCO will undervalue their importance in achieving the emission reductions. We have therefore used a fixed investment cost (4.570 €/kWp for PV and 1.350 €/kW for on-shore wind [34]) for all projects.

Results

There is only a marginal difference between the two scenarios. In the minimum scenario, the impact of this measure amounts to an average annual emission reduction of 11,5 kton CO_2.

4.3.30 OB-B02 Third party investment in energy savings in public buildings

Description

Via FEDESCO, investment in work in public buildings are made and may be reimbursed based on energy savings generated (see EC-C01).

Assumptions & calculation

The activities of FEDESCO are divided under PAMs EC-C01, for all investments in public buildings related to energy efficiency, and OB-B01, for all investments in public buildings related to PV panels.

4.3.31 OB-C02 Stimulation of alternative modes of transport

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 preferentially built or bought near railway stations.

Assumptions & calculation

The annual emission reduction is calculated using the following formula:

$$P \times D \times WD \times \left((EF_{bus} \times P_{bus} + EF_{tram} \times P_{tram} + EF_{metro \times} P_{metro}) - EF_{car}\right)$$

With:

D	Average distance to and from work (km)
WD	Average annual work days per year
NP	Increase in number of passengers with tram, bus or metro
EF	Emission factor of bus, tram, metro and car (kg/gm)
P	Proportion of passengers that use bus, tram or metro (%)

Employees using train to commute to work are included under measure TR-A08. Therefore we will only focus for this measure on 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 [35]. We assume that most federal civil servants using public transport will live in Brussels. We used the mobility questionnaire performed by the FPS Mobility for civil servants to compare the % of people using public transport between 2005 (before the measure) and 2008 (when measure was installed). It is estimated that the free rider effect will be significant, therefore not all people using public transport are considered, only the increase between 2005 and 2008. The data from FPS Mobility showed that in 2008 there were 0,4% more people using bus, tram and metro than in 2005. This percentage was considered constant during the period 2008-2020.

An important assumption is whether to include the emissions of the public transport in the final calculations. For public transport, an increase in the number of passengers does not necessarily have to imply and increase in vehicle kilometres (and related CO_2 emissions). In this calculation, we have assumed that this PAM did not result in increased vehicle kilometres. Therefore we have assumed that baseline emissions are zero (EF_{bus}, EF_{tram}, EF_{metro}), although we have included a minimum scenario including the mean emission factors of the different transport modi.

Results

This PAM has a minimal effect, with an annual emission reduction of 0,08 kton CO_2 in 2008 to 0,07 kton in 2020. This decrease throughout the period is the result of the increasing energy efficiency of cars. In the minimum scenario, where we have assumed that the modal shift has resulted in an increase of the number of vehicle-kilometres of bus, tram and metro, the annual emission reduction decreased to 0,03 kton CO_2 in 2008 and to 0,02 kton in 2020.

4.3.32 OB-C03 Promotion of bicycle use for civil servants

Description

A mileage allowance is granted to officials who use their bicycles between home and work.

Assumptions & calculation

The effect of this PAM is completely included in PAM TR-A03.

4.3.33 OB-C04 Teleworking for civil servants**

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.

Assumptions & calculation

The annual emission reduction is calculated using the following formula:

$$T \times D \times DD \times EF_{car}$$

With:

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

According to the NCP, 400 civil servants were teleworking in 2008. The website http://www.pdata.be/ showed that this number has increased to an average of 1.223 teleworkers in 2010 and 1.830 in 2011. For 2009 we interpolated the 2008 and 2010 data. In 2010 teleworkers worked 2.899 half days out at home, which is on average 1,19 days per week per teleworker. We have used this for the period 2008-2010. In 2011 this had increased to 1.23 days per week, which was used for the entire period 2011-2020. We thus assume that the average number of days teleworking will not increase further in the future.

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. [36] the average distance teleworkers commute is 51 km per day. Because it is difficult to quantify, for the calculation we assumed that people that work at home do not use more energy at home, although they probably do.

We have assumed two scenarios. The conservative estimate assumes no increase in the number of teleworkers after 2011. In the other scenario we have assumed that the linear increase between 2008 and 2011 will continue until 2020. In this scenario there would still only be around 5.400 teleworkers in 2020, which is less than 10% of the total number of civil servants in 2011 (excluding special civil servants, such as military and federal police).

Results

The emission reduction achieved by this measure is estimated to be a cumulative 3,1 kton CO_2 for the period 2008-2020 in the minimum scenario, and 6,2 kton in the maximum scenario.

4.3.34 OB-C07 Purchase of clean vehicles

Description

In 2004, environmental criteria were included in the purchase specifications of vehicles for federal institutions (including federal public services and scientific organizations) [37]. This was put in a circular letter, that stipulates that 50% of vehicle fleet must be conform the environmental specifications. In July 2009, this circular letter was revised and updated [38].

Assumptions & calculation

An average annual distance per vehicle was estimated based on figures from FPS Economy and FPS Mobility, resulting in an annual distance of 21.505 km per vehicle. From the ICDO/CIDD[11] website and personal communication with PODDO/SPPDD[12], we only

[11] Interdepartementale Commissie voor Duurzame Ontwikkeling – Commission Interdépartementale pour le Développement Durable.
[12] Programmatorische federale Overheidsdienst Duurzame Ontwikkeling – Service Public fédéral de Programmation Développement Durable.

obtained information for 2008, with a subdivision in classes based on emissions (from A to F). In 2008, 140 cars were replaced, which is 8% of the fleet. Thus, on average a car is replaced after 12 years, which suggests no early replacements. We assume that the same number of cars is replaced every year for the period 2008-2012. Almost 70% of cars bought in 2008 fulfilled the guidelines in the circular letter, which is higher than the 50% proposed. We assume that 66% of the cars are diesel cars and 33% gasoline cars, based on data from FPS Mobility on the registration of new cars. This information was used to estimate the average weighted emission factor of a new car for the Federal Public Services, 141,5 kg/km in 2008.

We assume that without this PAM the government would buy or lease a similar-sized car with an average emission instead of a cleaner car. Because no information was available on the size of the vehicle, only on emission factor, we set the baseline emission as the average emission of a new car [3]. The emission factor of new cars will continue to decrease, due to increased energy efficiency. This means that the difference in emission factors between an average new car on the market and a car fulfilling the criteria in the circular letter will decrease and eventually will become zero. In the minimum scenario, we have assumed that the circular letter will not differ and that at a given moment the impact of this measure will be zero. In a maximum scenario we have assumed that the environmental specifications will be adjusted so that the difference between the average car and the specifications remain constant.

Result

The effect of this PAM on emission reductions is very small, estimated to accumulate to 0,7 kton CO_2 over the entire period 2008-2020 in the minimum scenario. This increases to 1,1 kton CO_2 in the maximum scenario.

4.3.35 Green loans**

Description

The Federal government has taken this temporary measure in 2009 which will expire in 2011. For all loans used for energy saving technologies in residential buildings (with a minimum value of 1.250 and a maximum value of 15.000 €) the Federal government gives a subsidy corresponding to a reduction of the interest rate with 1,5%. The measure supports several technologies, including the technologies eligible for a tax deduction (EC-B01) and micro-CHP.

Assumptions & calculation

This PAM completely overlaps with measure EC-B01, because green loans can be combined with a tax deduction. Therefore the impact of this measure cannot be added to the total emission reductions by all federal PAMs.

The annual emission reduction is calculated as:

$$\sum_i (N_t \times P_i \times ER_i \times A_i)$$

With:

Σ	Summation for all types of investments eligible under this PAM
N_t	Cumulative number of green loans since 2009
P_i	Distribution between investments or technologies (%)
ER_i	Unit CO_2 reduction per investment (kg)
A_i	Allocation to federal measure per investment (%)

FPS Economy provided information on the number of green loans in the period October 2009 – September 2011. This provided information on the number of new green loans in 2009 and September 2011. Personal communication with FPS finance however showed that the number of requests per month fluctuates, yet that there is no continuous increasing trend in 2011. We therefore assume that the number of applications will remain constant for the rest of 2011. Based on previous information this gave an estimated number of new applications of 6.791 in 2009, 36.676 in 2010 and 78.951 in 2011.

To allocate the number of loans to the different technologies, we used the distribution observed in measure EC-B03 (FRGE, all applications). 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.

We used the unit emission reductions of measure EC-B01.

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.

Results

The measure has a significant effect (although not additional to the effect of EC-B01) on emission reductions. An annual emission reduction could be achieved of 162 kton in 2011 and onwards. For the entire period 2008-2020 a cumulative emission reduction is achieved of 1688 kton CO_2. We do have to stress that there could be a significant free rider effect, *i.e.* many of the applicants would have done the investment without this measure.

4.3.36 Eco-cheques

Description

The eco-cheque is a new extra-legal advantage that the employer can provide to workers, in the similar way as the gift check. 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”.

Assumptions & calculation

The eco-cheque effect has been fully analysed in a specific study of CO2 logic.

The results of this analysis have been considered as the upper bound of the expected impact of the eco-cheque. To be consistent with the other evaluations of the current study, the results have been adapted as follows:

- economy light bulb: no effect after 2013 because it becomes the standard;
- television: in the same way, the offer and the price reduction will naturally lead the purchase choice to the LED technology;
- freezers: the standard for freezer becomes A+ and will soon become A++;
- bicycle: it has been assumed that the bicycle purchased is used one a week for a short travel.

Results

The impact of the measure is presented in the graph hereunder. The low level from 2017 is explained by the evolution of the “standards” (label A+, economy bulb...). Therefore the eco-cheque will no more influence the purchase.

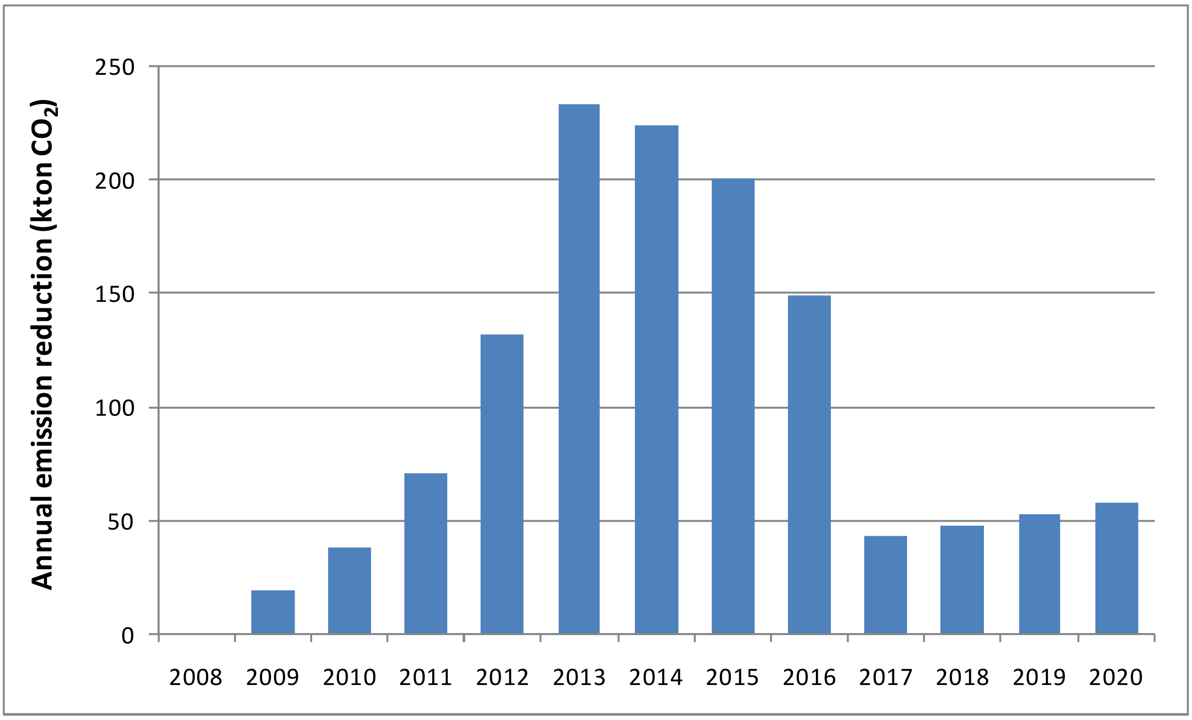

Figure 21. Results for the Eco-cheque.

5 OVERVIEW OF THE RESULTS

5.1 Mean values

The emission reductions (in kton CO_2) that have been quantified are presented in Table 26, by PAM. For those PAMS with more than one scenario, the table shows the mean scenario in case three scenarios were estimated or in case of a Monte Carlo analysis; or the minimum scenario, in case only two scenarios were considered. Two exceptions are measure EP-A02, where the maximum scenario assumes an increase in the use of biomass in the future, as can be expected from several studies, and measure TR-D01, where the maximum scenario remains below the objective for renewables in the European 20/20/20 climate package.

It should be reminded that these figures are based on assumptions, of which some relate to policy decisions that are still expected. This is in particular the case of the high impact measure Offshore wind energy.

Note that in this table the impact of the following measures is included under another measure:

- TR-C02 (promoting purchase of clean cars), which is included in TR-C01 (tax reduction for clean cars);
- SE-A01 to SE-A07 (promotion and awareness raising campaigns), which are all included in measures relating to RUE and transport (*e.g.* EC-B01 and TR-A08);
- OB-C03 (promoting bicycle use for federal civil servants) which is included in TR-A03 (promoting bicycle use in general);
- Green loans, which is included in EC-B01.

Table 26. Overview of the estimated emission reductions achieved by the federal PAMS.

	2008	2009	2010	2011	2012	2020	total 2008-2012	average 2008-2012	rel. contribution 2008-2012
EP-A01 & EP-A05**	0	31	72	238	356	2356	697	139	4,6%
EP-A02 & EP-A03**	87	101	101	101	101	101	490	98	3,3%
EP-B01	NE: negligible - no influence of the autorisation on the installation								
EC-A05	NE: there is no measure on the labels themselves								
EC-B01**	856	1171	1464	1740	2025	4302	7256	1451	48,2%
EC-B02	NE: in Kyoto protocol emission from biomass are null. Not relevant.								
EC-B03**	0,0	0,2	0,5	1,2	1,8	6,9	3,7	0,7	<0,1%
EC-B04	NE: the effect of this measure is not quantifiable.								
EC-C01 & OB-B02	6,6	20	33	46	59	132	165	33	1,1%
IP-A06**	109	134	158	183	208	247	791	158	5,3%
TR-A01	NE: At least partially included under TR-A02 and TR-A03.								
TR-A02**	188	188	225	251	276	414	1127	225	7,5%
TR-A03	5,0	6,7	8,5	10,1	10,0	9,0	40	8	0,3%
TR-A04	15	12	8	11	13	33	59	12	0,4%
TR-B01	11	11	10	10	10	10	53	11	0,4%
TR-B03	NE: no concrete decision.								
TR-B05	0,0	0,0	7	11	14	43	32	6	0,2%
TR-C01**	23	28	71	130	181	156	432	86	2,9%
TR-D01**	295	617	895	895	895	895	3598	720	23,9%
AG-C02	NE: not relevant for Belgium, wood mainly coming from abroad.								
AG-D04	NE: in Kyoto protocol emissions from biomass are null.								
AG-E01	NE: in Kyoto protocol emissions from biomass are null.								
WA-A01	NE: the measure concerns only a minute fraction of the waste. Impact on GHG negligible								
SE-A08	NE: no evidence of a positive impact on emissions.								
OB-A01	NE: no evidence of a positive impact on emissions.								
OB-A02	NE: only pilot project on Federal canteen of SPF Finance. Negligible								

	2008	2009	2010	2011	2012	2020	total 2008-2012	average 2008-2012	rel. contribution 2008-2012
OB-A03**	9,5	9,5	15	6	6	14	46	9	0,3%
OB-B01**	0,0	0,0	0,0	1,1	9,2	17,5	10	2	<0,1%
OB-C02	0,0	0,0	0,0	0,0	0,0	0,0	0	0	<0,1%
OB-C04**	0,1	0,1	0,2	0,3	0,3	0,3	1	0	<0,1%
OB-C07	0,0	0,0	0,0	0,0	0,1	0,1	0	0	<0,1%
Eco-cheques	0,0	19	38	71	132	58	261	52	1,7%
*Green loans** [a]*	*0,0*	*8,6*	*57*	*162*	*162*	*162*	*390*	*78*	
Total	**1599**	**2342**	**3095**	**3682**	**4273**	**8842**	**14990**	**2998**	**100%**

** measures that have been updated and adjusted compared to the final report 2011

[a] Green loans are included in measure EC-B01 and therefore not include in the total

5.2 Ranges

The uncertainty on the parameters for which assumptions have been made can have a large effect on the projected emission reductions for 2008 to 2012. In Table 27 we have listed the measures for which we have assessed a range for the possible level of impact. This range is either based on an assessment of probability distribution (Monte Carlo simulation for measure EC-B03) or on direct assumptions. We have focused on measures with a significant impact on emission reductions.

Table 27. Estimated minimum and maximum emission reductions (kton CO2) for the PAMs with the largest impact on emission reductions

		2008	2009	2010	2011	2012	2020
EP-A01	Min	0	31	72	238	356	2.356
	Max	0	31	72	279	418	2.508
EP-A02	Min	87	101	101	101	101	101
	Max	87	101	104	113	122	141
EC-B01	Min	644	937	1.208	1.447	1.684	3.481
	Max	1.068	1.405	1.721	2.033	2.365	5.123
EC-B03	Min	0	0,2	0,5	1,2	1,4	3,2
	Max	0	0,2	0,5	1,2	2,2	21,2
EC-C01	Min	7	20	33	46	59	132
	Max*	7	20	33	46	59	132
TR-A02	Min	125	125	150	167	184	276
	Max	281	281	337	376	414	621
TR-C01	Min	11	15	38	72	104	135
	Max	25	34	86	162	233	303
TR-D01	Min	295	617	895	895	895	0
	Max	295	617	895	895	895	895
OB-A03	Min	9,5	9,5	15,2	5,5	6,5	13,9
	Max	9,5	9,5	15,2	5,5	6,5	16,7
OB-B01	Min	0	0	0,02	1,1	9,2	17,5
	Max	0	0	0,02	1,1	9,2	18,2
OB-C04	Min	0,1	0,1	0,2	0,3	0,3	0,3
	Max	0,1	0,1	0,2	0,3	0,3	0,9
OB-C07	Min	0,01	0,02	0,04	0,05	0,06	0,06
	Max	0,01	0,02	0,04	0,05	0,06	0,15

EC-B01: based on different assumptions with respect to *e.g.* unit CO_2 emission reductions, distribution of tax deductions among different technologies and increase of number of tax deductions for 2008-2012.
* scenarios do not differ for the years shown in this table.

6 ANNEXES

6.1 Annex 1: Relationship with the database of the National Climate Plan

In 2007, ECONOTEC, Know it! and Vito performed a study ordered by the Permanent Secretariat of the National Climate Commission, to develop and indicator database for the National Climate Plan (NCP). In line with the Cooperation Agreement of 14/12/2002, the following tasks are assigned to the Permanent Secretariat:

- develop a method to monitor and evaluate yearly the National Climate Plan;
- execute and Report the evaluation of the NCP;
- formulate adjustments/improvements to the NCP.

There was a need to have a monitoring and evaluation tool for the NCP and its reports. In the study performed in 2007, the consortium has:

- developed a central database system which can contain relevant information and makes it possible to extract reports from the information in the database (restricted online system available for all contacts involved in the NCP). Internationally, there are several reporting obligations:
    - National Communication to the UNFCCC (every 4 years)
    - Annual report to the EU (32 indicators)
    - Biannual report to the EU (projected progress report)
- developed a website for the National Climate Commission (http://www.cnc-nkc.be);
- developed a set of possible indicators for monitoring and evaluating the NCP (mainly at target and cluster level), including an inventory of the availability of data for the set of indicators.

The indicators in the previous study were ‘ex post’ indicators, meaning that the indicators were for evaluating and monitoring the past. Indicators were classified in ‘types’ and ‘categories’.
The types of indicators were:

- *Follow-up indicator*:indicator allowing to measure the progress made in implementing a measure, which could be an input or an output indicator (see indicator ‘categories’ below),
- *Social indicator* : for example impact on employment,
- *Economic indicator*: for example impact on economic growth, value added,
- *Ecological indicator*: relate to CO_2 emissions or CO_2 emission reduction

The categories of indicators were:

- *Input indicator* : measures resources allocated for a particular measure or group of measures (budget, personnel…),
- *Output indicator* : follow-up indicator that is not an input indicator (TJ saved, MW cogeneration installed, m^2 solar panels, km bicycle paths…),
- *Outcome indicator* :impact indicator, measures progress towards reaching a particular target or cluster of the NCP (mainly CO_2-eq emission reductions),
- *Effect indicator* :indicator measuring an impact unrelated to a target of the NCP (NO_x emission reduction, air quality improvement, impact on employment…).

Typical indicators with high relevance, are the ecological indicators relating to CO_2 reductions. They may be the absolute emission level, a specific emission level (for example CO_2 per activity like number of passenger-km), or a reduction level. There are 2 types of emission reduction indicators possible:

- an emission reduction compared to a reference year like 1990;
- an emission reduction compared to a baseline-reference. For each indicator, the reference needs to be properly defined.

In the previous study, ex post ecological indicators concerning CO_2 reductions were included in the list of suggested indicators only on the level of targets and clusters of measures. They can however also be defined at the individual measure level.

In this study, the objective is to calculate the avoided CO_2 emissions for each year in the period 2008-2012, for each federal measure. In fact, this study tries to calculate the values of ex ante ecological indicators at measure level. The typology of the set of ex post indicators listed in 2007 is perfectly suitable for application to ex ante indicators. Also, the database that was developed can technically be used to fill in ex ante indicators.

For the biannual report to the European Commission (“projected progress report”), there is a request to fill in estimates of GHG emission reduction effect or sequestration effect in Gg CO_2eq per year per measure or policy for the years 2010, 2015 and 2020. The methods and values calculated in this study could be used to complement this report.

6.2 Annex 2: list of Excel files per measure

The Excel files that have been established for calculating the impact on CO_2 emissions of particular measures are the following:

EP-A01 & EP-A05	Offshore wind energy
EP-A02 & EP-A03	Tax on fossil fuels for electricity production
EC-B01	Financial incentives for rational use of energy: Crystal ball calculation sheet + background information sheet
EC-B03	Specific RUE aid for unprivileged people
EC-C01 & OB-B02	Energy efficiency investments in public buildings via FEDESCO
IP-A06	Tax deduction for energy saving investments by companies
TR-A02 & TR-A08	Improvement and promotion of public transport
TR-A03	Promoting bicycle use
TR-A04	Multimodal transport of goods
TR-B01	Promoting car pooling
TR-B05	Eco-driving
TR-C01	Tax reduction on the purchase of clean vehicles
TR-D01	Promotion of biofuels
OB-A03	EMAS certification
OB-B01	Photovoltaic panels on roofs of Federal government buildings
OB-C02	Stimulation of alternative modes of transport
OB-C04	Teleworking for civil servants
OB-C07	Purchase of clean vehicles
---------	Green loans
---------	Eco-cheques

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