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Impact of the EU Climate-Energy Package on the Belgian energy system and economy - Update 2010

Study commissioned by the Belgian federal authority

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Abstract - By the end of 2008, the Federal Planning Bureau published the Working Paper 21-08. This Working Paper described and analysed the impact of the EU Climate-Energy Package on the Belgian energy system and economy. Since then, however, a lot has changed: the macroeconomic projections altered radically further to the financial and economic crisis, recent developments in the field of oil and gas supply and demand made fossil fuel price projections to be revised upwards and a number of energy efficiency measures were agreed upon and put into law in the course of 2008 and 2009. All this made the 2008 study less relevant whilst only 2 years old. This study report then updates the analysis reported in the Working Paper 21-08 and dedicates special attention to the stepping up to -30% for the EU greenhouse gas reduction target. It is based on the new economic and policy context and benefits from recent analyses of the European Commission conducted at EU level.

Jel Classification - Q4, C6, O2
Keywords - Energy policy, climate policy, long term energy projections, greenhouse gas emissions, macroeconomic impact

Executive summary

The context

At the end of 2008, the Federal Planning Bureau published the Working Paper 21-08 (WP 21-08). This Working Paper described and analysed the impact of the EU Climate-Energy Package on the Belgian energy system and economy. The starting point of the analysis was the Impact Assessment and its annexes released by the European Commission in January 2008. Some scenarios were studied taking into account the stepping up from the EU effort of a 20% reduction in greenhouse gas (GHG) emissions by 2020 to a 30% decrease. All these scenarios were designed based on best available knowledge at the time.

Meanwhile, a lot has changed. First and foremost, the financial and economic crisis erupting in the third quarter of 2008 has had a non-negligible impact on nations' GDP. Hence, the macroeconomic projections from then on have changed radically compared to what could be expected in 2007, the year of the analysis. In addition, recent developments in the field of oil and gas made fossil fuel price projections to be revised upwards. Finally, a number of energy efficiency measures were agreed upon and put into law in the course of 2008 and 2009. All this made the 2008 study less relevant though only 2 years old.

To take into account the changed outset and expectations and to honour the commitment of a -30% analysis in response to the March 2010 Council conclusions, the European Commission came up in 2010 with a revised baseline and an update of the package study, as well as an analysis of options to move beyond a 20% European GHG reduction in 2020. More recently, in March 2011, the European Commission released a new communication presenting a Roadmap for moving to a competitive low-carbon economy in 2050. This communication and its accompanying impact assessment shed new light on the EU GHG reduction target in 2020.

This study report is based on the new economic and policy context and benefits from the analyses of the European Commission conducted at EU level. It follows the same structure as WP 21-08. Next to a baseline, alternative scenarios are scrutinized: the *20/20 target* scenario and *30/20 target* scenarios, respectively reflecting a 20% and 30% reduction of GHG emissions at EU level in 2020 compared to 1990 and a EU 20% share of renewable energy sources (RES) in the gross final energy demand in 2020. The study also includes a couple of variants which evaluate the impact of achieving more GHG emission reductions domestically in the Belgian non-ETS sector than considered in the alternative scenarios.

In modelling terms, the scenarios and variants differ in carbon and renewable values as can be seen in the table below.

Overview of carbon and renewable values in the different scenarios and variants, year 2020

	Baseline	20/20 target		30/20_flex target		30/20_int target	
		20/20	20/20_alt1	30/20_flex	30/20_flex_alt2	30/20_int	30/20_int_alt3
ETS – CV in €/tCO_2	25.0	16.5	16.5	30.2	30.2	55.4	55.4
non-ETS							
- CV in €/tCO_2	0.0	5.3	41.5	30.2	50.7	55.4	82.4
- GHG (% change 2005-2020)	-1.9	-7.2	-11.0	-11.5	-14.0	-14.3	-17.0
RES							
- RV in €/MWh	0.0	82.0	82.0	82.0	82.0	82.0	82.0
- Share in GFED (%)	6.9	12.5	12.6	12.8	13.0	13.2	13.3

CV = carbon value; RV = renewable value.
GFED = Gross Final Energy Demand.

The study encompasses the analysis of the impact of each scenario (or variant) on the Belgian energy system, GHG emissions and the direct cost of compliance (using the PRIMES model and results from the GAINS model) and integrates a subsequent analysis of the broader macroeconomic impact of stepping up to -30% (using the HERMES model).

Impact of the Climate-Energy legislative Package…

…on the Belgian energy system

The new analysis confirms the results of the WP 21-08: energy savings and RES deployment are the main responses of the Belgian energy system to the targets. Compared to the baseline, the scale of energy savings is nevertheless lower than in WP 21-08. In 2020, final energy demand declines less compared to the baseline: 1% compared to almost 6% in WP 21-08. The lower economic growth projection due to the financial and economic crisis makes the achievement of the GHG reduction target easier, i.e. less energy savings are required compared to the baseline. Final energy demand is projected to be around 39 Mtoe in 2020 (against 38.4 Mtoe in 2005) in the *20/20 target* scenario, i.e. its average annual growth rate amounts to 0.1% over the period 2005-2020. In relative terms, energy savings are the highest in the tertiary sector and the lowest in industry; energy savings concern all energy forms but RES.

By contrast, RES deployment is comparable in both studies: roughly 5 Mtoe (or 57 TWh) in 2020. This level translates into a 12.5% share of gross final energy demand. The deficit compared to the 13% target set for Belgium is balanced by cooperation mechanisms.

The demand for electricity grows by 0.7% per year on average between 2005 and 2020 compared to 0.8% in the baseline and compared to 1.3% in the previous *20/20 target* scenario. The lower growth rates recorded in this update reflect the economic downturn and the effect of policies and measures like the implementing measures of the Ecodesign and Labelling directives. The share of RES in power generation is projected to be close to 22%, compared to 19% in WP 21-08 and 15% in the new baseline. The increase in RES-based electricity production takes place at the expense of coal and natural gas. Furthermore, the new study is comparatively 'more optimistic' as regards the development of wind and solar PV power capacities but slightly 'less optimistic' concerning biomass-based power capacities.

Imports of all fossil fuels (i.e. oil, natural gas and coal) decrease compared to the baseline. In monetary terms, this drop translates into a saving of about 1.2 billion € in 2020 (in € of 2008). This figure is of the same order of magnitude as in WP 21-08: in the update, higher international fuel prices compensate for a comparatively lower decrease in fossil fuel imports compared to baseline.

...on GHG emissions

The implementation of the legislative Climate-Energy Package in Belgium leads to a domestic reduction of total GHG emissions by 14% in 2020 compared to 2005. In the ETS, GHG emissions decrease by 23%. Emission developments in this sector are dealt with at EU level, no national target applies. In the non-ETS, GHG emissions drop by roughly 7% in 2020 compared to the level of 2005. The residential sector is the major contributor to this decreasing trend, both in relative and absolute terms. Access to flexibility mechanisms is assumed to fill the gap with respect to the -15% target.

The following table summarizes key energy and emission results for the baseline and the *20/20 target* scenario and variant.

Summary of key results, comparison between baseline and *20/20 target* scenario and variant, year 2020

			Baseline	20/20 target	
				20/20	20/20_alt1
Prices	ETS	CV (€/tCO_2)	25.0	16.5	16.5
	Non-ETS	CV (€/tCO_2)	0.0	5.3	41.5
	RES	RV (€/MWh)	0.0	82.0	82.0
Quantities	FED	wrt baseline (%)	-	-1.0	-2.0
	Elec demand	average annual growth rate '05-'20 (%)	0.8	0.7	0.8
	ETS GHG	wrt baseline (%)	-	-14.3	-11.7
	Non-ETS GHG	wrt baseline (%)	-	-5.4	-9.3
	Total GHG	wrt baseline (%)	-	-9.0	-10.3
	RES	consumption (ktoe)	2752	4952	4979

FED = Final Energy Demand; wrt = with respect to.
Source: PRIMES input and results.

...on total direct cost

The total direct cost encompasses the additional costs, compared to the baseline, experienced by the Belgian energy consumers, related to the domestic GHG mitigation and RES production efforts and to the purchase of flexibility (in the non-ETS and for RES). The total direct cost of implementing the legislative Climate-Energy Package is valued at 1.2 billion € in 2020 (in € of 2008), i.e. 0.3% of Belgian GDP in 2020. This is about half the figure calculated in WP 21-08. Energy related expenses constitute the major component of the total direct cost (the other component is the disutility cost); they encompass equipment and fuel purchase costs. Compared to the baseline, energy related expenses rise by 900 million € in 2020 (in € of 2008).

The lower estimated total direct cost is partly due to the economic crisis, higher international energy prices as well as implemented policy measures in the baseline which reduce the GHG emission reduction effort needed in the non-ETS compared to WP 21-08. Another part of the explanation comes from the fact that the EU ETS target is already met in the baseline, which was not the case in the baseline designed in WP 21-08.

...if higher GHG reductions are required domestically in the non-ETS

The analysis of the EU Climate-Energy Package was complemented (scenario *20/20_alt1* in the table) by an evaluation of the impact of imposing higher GHG emission reductions on the Belgian non-ETS sector, namely 11% in 2020 compared to 2005, instead of 7% in the *20/20 target* scenario. The main results of this evaluation are the following: (1) putting a limit on the flexibility in the non-ETS favours fuel substitution towards electricity; (2) consequently, GHG emissions in the ETS are reduced less between 2005 and 2020 than in the *20/20 target* scenario (-21% against -23%); (3) the total direct cost increases to reach 1.4 billion € in 2020, i.e. 16% above the total direct cost estimated for the *20/20 target* scenario. The extra cost is essentially due to disutility costs.

Impact of a stepping up to -30% for the GHG reduction target at EU level in 2020...

Similarly to the analyses of the European Commission, two -30% scenarios are analyzed in this study: one counting on a complete internal EU response to the stepping up and flexibility only taking place between the EU's Member States (*30/20_int target* scenario), the other being a scenario in which the EU settles its obligations with the possibility to make use of flexibility mechanisms for half of the additional effort (*30/20_flex target* scenario). The carbon values needed to simulate these two scenarios are reported in the first table. The renewable value is assumed to be the same as in the *20/20 target* scenario.

It is worth noting that, contrary to the analysis of the *20/20 target* scenario, the analysis of the *30/20 target* scenarios designed for this study is not directly comparable to the one presented in WP 21-08 for two main reasons. Firstly, the two *30/20 target* scenarios discussed here are designed in a longer-term perspective (2050). This means that they are both consistent with a 2°C objective, which translates, for the EU, into a cost-efficient emission reduction pathway of GHG emissions by 40% in 2030 and by 80% in 2050, below 1990. Secondly, the impact of the *30/20 target* scenarios is described in comparison with the *20/20 target* scenario and not in comparison with the baseline (as in WP 21-08).

In this executive summary, the focus will be on the results of the *30/20_flex target* scenario. Results of the *30/20_int target* scenario and the variants are provided where relevant.

...on the Belgian energy system

The stepping up to -30% leads to a further cut in final energy demand by 3% in 2020 compared to the *20/20 target* scenario. The tertiary and residential sectors are the most affected both in relative and absolute terms. Most energy forms are cut back. The only exception is RES whose final consumption remains equal to the level in the *20/20 target* scenario in 2020.

The demand for electricity grows by 0.6% per year on average over 2005-2020 compared to 0.7% in the *20/20 target* scenario. Notwithstanding the small drop in electricity production, the fuel mix is not much affected. In particular, the share of RES in power generation is equal to 22% in 2020 as is also the case in the *20/20 target* scenario.

The drop in final energy demand combined with the same incentive for RES (i.e. same renewable value) leads to a slightly higher share of RES in gross final energy demand: 12.8% against 12.5% in the *20/20 target* scenario. As a consequence, the gap with the target (13%) is reduced and hence the recourse to cooperation mechanisms.

The effect on final energy demand translates into a decline in fossil fuel imports. In monetary terms, this means a saving of about 0.5 billion € in 2020, on top of the saving of 1.2 billion € evaluated in the *20/20 target* scenario.

In case of a complete internal EU response to stepping up to -30% (*30/20_int target* scenario), the above described effects become stronger: the further cut in final energy demand becomes 5%, the share of RES in gross final energy demand 13.2% and the saving from the decrease in fossil fuel imports 0.9 billion €.

...on GHG emissions

Total GHG emissions are 5% below the level in the *20/20 target* scenario in 2020. The reduction percentages are respectively 5.9% and 4.7% in the ETS and non-ETS. The major contributor to further GHG emission reductions in Belgium, both in absolute and relative terms, is the energy sector. It is followed by the tertiary and domestic sectors and the sectors responsible for non-CO_2 emissions. From the 2005 level, stepping up to -30% leads for Belgium to a reduction of total GHG emissions by 18% in 2020.

In case of a complete internal EU response to stepping up to -30% (*30/20_int target* scenario), Belgium's total GHG emissions are projected to be 9% below the level of the *20/20 target* scenario in 2020.

To summarize the energy and emissions' impact of the *30/20 target* scenarios, the following table depicts a selection of results in a comprehensive manner.

Summary of key results, comparison between the *20/20 target* and the *30/20 target* scenarios and variants, year 2020

		20/20 target	30/20_flex target		30/20_int target	
		20/20	30/20_flex	30/20_flex_alt2	30/20_int	30/20_int_alt3
Prices						
ETS	CV (€/tCO_2)	16.5	30.2	30.2	55.4	55.4
Non-ETS	CV (€/tCO_2)	5.3	30.2	50.7	55.4	82.4
RES	RV (€/MWh)	82.0	82.0	82.0	82.0	82.0
Quantities						
FED	wrt 20/20 target (%)	-	-2.9	-4.4	-5.4	-7.0
Elec demand	average annual growth rate '05-'20 (%)	0.7	0.6	0.5	0.5	0.5
ETS GHG	wrt 20/20 target (%)	-	-5.9	-7.3	-12.2	-12.4
Non-ETS GHG	wrt 20/20 target (%)	-	-4.7	-7.3	-7.6	-10.6
Total GHG	wrt 20/20 target (%)	-	-5.1	-7.3	-9.4	-11.3
RES	consumption (ktoe)	4952	4941	4929	4983	4931

FED = Final Energy Demand; wrt = with respect to.
Source: PRIMES input and results.

...on the Belgian economy

The evaluation of the economic cost for Belgium of stepping up to -30% involves two complementary approaches. The first approach relies on the assessment of the direct cost. The second approach deals with the macroeconomic impact.

The total direct cost of stepping up to -30% (i.e. the additional cost compared to the *20/20 target* scenario) is projected to amount to about 0.8 billion € in 2020, i.e. 0.20% of GDP in 2020. This is the result of an increase in costs related to domestic effort and, to a lesser extent, a rise in the purchase of flexibility in the non-ETS and a decrease in the purchase of RES flexibility. It is worth underlining that the large part of the additional cost is due to disutility costs. If one sticks to energy related expenses, model results show a decrease compared to the *20/20 target* scenario (-0.9 billion €'08 in 2020).

In case of a complete internal EU response to stepping up to -30% (*30/20_int target* scenario), the total direct cost (i.e. the additional cost compared to the *20/20 target* scenario) is valued at 1.3 billion € in 2020, i.e. 0.32% of GDP in 2020. Energy related expenses also drop compared to the *20/20 target* scenario (-1.6 billion €'08 in 2020, i.e. 0.39% of GDP).

Imposing a limit on the use of flexibility in Belgium for the achievement of the non-ETS target (variants alt2 and alt3) has an impact on the total direct cost of the stepping up to -30%: in 2020, the latter increases by respectively 7% and 19% in the *30/20_flex_alt2 target* and *30/20_int_alt3 target* scenarios (energy-related expenses, however, drop further by about 400 million €'08 in both variants).

As the direct cost does not account for the feedback effects on the Belgian economy and its sectors, a macrosectoral analysis was carried out with the HERMES model. Indeed, from a macro-economic perspective, one needs to take into account the changes in agents' behaviour and in the level of demand that result from the rise in costs and prices implied by the higher energy prices. What is more, recycling policies of the additional public revenues generated by the implementation of GHG emission reduction strategies are interesting to consider, since they could have impacts on the firms' production cost.

Several links are required between the PRIMES-based analysis and the HERMES model to make the analysis consistent.

Firstly, the carbon values reported above constitute an input for the macro-economic analysis. The introduction of the carbon values leads to an increase in energy prices which depend, among others, on the CO_2 content of the various energy forms (in 2020, the average increase in energy prices of the *30/20_flex target* scenario and of the *30/20_int target* scenario with respect to the *20/20 target* scenario would be 4.7% and 9.8%, respectively). For the ETS sector, the carbon value can be interpreted as the price of the EU allowances on the market. For the non-ETS sector, the carbon value is a measure in monetary terms of the stringency of the emission reduction constraints in this sector. It has to be considered as the price-signal needed to induce the corresponding emission reduction by the economic agents.

The auction of EU ETS allowances provides new public revenues for the country. Additional receipts may also be captured in the non-ETS sector if the government succeeds in implementing revenue-generating instruments, such as a carbon tax, in this sector. HERMES simulates two cases regarding the recycling of those additional public receipts generated by a GHG reduction policy:

– No recycling policy: the new public revenues are not recycled but are used to reduce public debt.
– Full recycling policy: all additional public revenues (ETS + non-ETS) are recycled in reductions of social contributions paid by employers. The full recycling option is calibrated to be tax neutral for the public authorities, meaning that the new public revenues generated are exactly offset by tax reductions elsewhere.

Secondly, the future electricity prices as well as the structure of the electricity production park from PRIMES are used as an input for the macroeconomic analysis. The RES target is therefore taken into account to the extent that it has an impact on the electricity sector and on carbon values.

Thirdly, the amounts paid regarding the flexibility allowed are introduced in HERMES.

Some variables related to the macroeconomic international environment were adjusted since GHG emission reduction policies take place in Europe as a whole, where they will generate macroeconomic impacts as well. Those changes concern the evolution of international prices and the potential export markets for Belgium and were simulated by means of the European macrosectoral model NEMESIS.

Simulations were run for both *30/20 target* scenarios (*_flex* and *_int*) and their results were compared to those of the *20/20 target* scenario. The impacts can be quite different depending on the chosen flexibility scenario and according to whether the newly generated public revenues are recycled or not. Indeed, in the case of a “no recycling” option, real GDP would be reduced by 0.4% in 2020 in the *30/20_flex target* scenario, as a consequence of diminishing exports and of a downturn in domestic demand. This corresponds to a decrease in the average annual economic growth of about 0.05 percentage points over the period 2013-2020. This effect would be doubled in the *30/20_int target* scenario (-0.8% of GDP in 2020, i.e. an average annual loss of 0.1%). Employment would also be negatively affected by the policy, with a loss in 2020 evaluated at about 24000 jobs in the *30/20_flex target* scenario and at almost 47 000 jobs in the *30/20_int target* scenario. On the other hand, if a “full recycling” policy of the newly generated public revenues is implemented, the impact on GDP of the increase in energy prices would be much more limited in both scenarios. The reduction in real GDP would be close to 0.15% in 2020 in both cases, meaning a slowdown of the average annual economic growth of less than 0.02 percentage points over the simulation period. Furthermore, the “full recycling” policy would have a positive effect on employment, which would be stimulated thanks to the reduction of the wage costs per worker due to the cut in social security contributions paid by employers. In the *30/20_flex target* scenario, about 7 000 jobs would be added to those of the *20/20 target* scenario in 2020. The impact would still be stronger in the *30/20_int target* scenario, with about 25 000 additional jobs.

Synthèse

Contexte

Fin 2008, le Bureau fédéral du Plan a publié le Working Paper 21-08 (WP 21-08). Celui-ci décrit et analyse l'impact du Paquet européen Climat-Energie sur le système énergétique et l'économie belges. A cette fin, nous nous étions basés sur l'analyse d'impact et ses annexes publiés en janvier 2008 par la Commission européenne. Certains scénarios avaient étudiés l'impact d'une intensification de l'effort européen de réduction des émissions de gaz à effet de serre (GES) en 2020 de 20% à 30%. L'ensemble des scénarios avaient été établis sur la base des meilleures connaissances disponibles à ce moment.

Dans l'intervalle, la situation a fortement évolué. Tout d'abord, la crise économique et financière qui a éclaté au troisième trimestre de 2008 a eu un impact non négligeable sur les PIB nationaux. Par conséquent, les perspectives macroéconomiques diffèrent sensiblement de ce que nous avions prévu en 2007, année où l'analyse avait été réalisée. De plus, les récentes évolutions dans les domaines du gaz et du pétrole ont entraîné une révision à la hausse des perspectives relatives au prix des combustibles fossiles. Enfin, une série de mesures liées à l'efficacité énergétique ont été approuvées et introduites dans la législation en 2008 et 2009. Pour toutes ces raisons, l'étude publiée en 2008 a perdu de sa pertinence alors qu'elle n'a que deux ans.

Afin de prendre en compte ces changements et d'analyser l'objectif de 30 % repris dans les conclusions du Conseil européen de mars 2010, la Commission européenne a revu en 2010 son scénario de référence, mis à jour ses études préparatoires et analysé les actions à entreprendre pour aller au-delà des 20% de réduction des gaz à effet de serre en Europe d'ici 2020. Plus récemment, en mars 2011, la Commission européenne a publié une feuille de route vers une économie à faible intensité de carbone à l'horizon 2050. Cette communication, ainsi que l'analyse d'impact qui l'accompagnait, ont jeté une lumière nouvelle sur l'objectif de réduction des GES dans l'Union européenne d'ici 2020.

La présente étude tient compte du nouveau contexte économique et politique tout en tirant profit des analyses réalisées au niveau européen par la Commission européenne. Elle présente la même structure que le WP 21-08. Outre le scénario de référence, d'autres scenarios sont examinés : le scénario *20/20 target* et le scénario *30/20 target*, qui visent respectivement à réduire de 20% et de 30% par rapport à 1990 les émissions de GES au niveau européen d'ici 2020 et à porter à 20% la part des sources d'énergie renouvelables dans la demande finale brute d'énergie en 2020. L'étude comprend également des variantes destinées à évaluer l'impact d'une réduction plus importante des GES dans le secteur non ETS belge.

Le tableau ci-dessous montre comment la valeur du carbone et la valeur des énergies renouvelables varient selon le scénario et la variante.

Aperçu de la valeur carbone et de la valeur des énergies renouvelables dans les différents scénarios et variantes, année 2020

	Scénario de référence	20/20 target		30/20_flex target		30/20_int target	
		20/20	20/20_alt1	30/20_flex	30/20_flex_alt2	30/20_int	30/20_int_alt3
ETS – CV en €/tCO_2	25.0	16.5	16.5	30.2	30.2	55.4	55.4
Non ETS							
- CV en €/tCO_2	0.0	5.3	41.5	30.2	50.7	55.4	82.4
- GES (% évolution 2005-2020)	-1.9	-7.2	-11.0	-11.5	-14.0	-14.3	-17.0
SER							
- RV en €/MWh	0.0	82.0	82.0	82.0	82.0	82.0	82.0
- Part dans la CFBE (%)	6.9	12.5	12.6	12.8	13.0	13.2	13.3

CV = valeur carbone ; RV = valeur des énergies renouvelables.
CFBE = consommation finale brute d'énergie.

L'étude analyse l'impact de chaque scénario (ou variante) sur le système énergétique belge, les émissions de GES et les coûts directs liés à la mise en œuvre des objectifs (en utilisant le modèle PRIMES et les résultats du modèle GAINS). Elle examine aussi l'impact macroéconomique de l'objectif de réduction de 30% des GES (en utilisant le modèle HERMES).

Impact du Paquet législatif Climat-Energie…

…sur le système énergétique belge

La nouvelle analyse confirme les résultats du WP 21-08 : les économies d'énergie et l'utilisation de sources d'énergies renouvelables constituent les principaux ajustements du système énergétique belge aux objectifs fixés. Toutefois, par rapport au scénario de référence, les économies d'énergie réalisées sont moins importantes que celles mentionnées dans le WP 21-08. En 2020, la demande finale d'énergie est réduite de 1%, contre près de 6% dans le WP 21-08, soit un recul plus faible comparé au scénario de référence. Les perspectives de croissance économique étant moins favorables suite à la crise économique et financière, l'objectif de réduction des GES peut être plus facilement atteint. En d'autres mots, moins d'économies d'énergie sont nécessaires par rapport au scénario de référence. Dans le scénario *20/20 target*, la demande finale d'énergie devrait atteindre environ 39 Mtep en 2020 (contre 38,4 Mtep en 2005), ce qui représente une croissance annuelle moyenne de 0,1% sur la période 2005-2020. En termes relatifs, les économies d'énergie sont principalement réalisées dans le secteur tertiaire, tandis que l'industrie est le secteur le moins concerné. Les économies d'énergie touchent toutes les formes d'énergie, à l'exception des sources d'énergie renouvelables.

Les SER, quant à elles, atteignent un volume comparable dans les deux études : environ 5 Mtep (ou 57 TWh) en 2020. Ce niveau représente une part de 12,5% dans la demande finale brute d'énergie, les mécanismes de coopération permettant de combler l'écart avec l'objectif de 13% assigné à la Belgique.

La demande d'électricité augmente en moyenne de 0,7% par an entre 2005 et 2020, contre 0,8% dans le scénario de référence et 1,3% dans le scénario *20/20 target* précédent. Ce ralentissement de croissance fait suite au fléchissement de l'activité économique et à l'application de certaines mesures, comme la mise en œuvre des directives écoconception et étiquetage. La part des SER dans la production d'électricité devrait s'élever à environ 22%, contre 19% dans le WP 21-08 et 15% dans le nouveau scénario de référence. La production d'électricité à partir de SER augmente, au détriment du charbon et du gaz naturel. De plus, la nouvelle étude est plus optimiste par rapport à l'évolution des énergies éolienne et photovoltaïque, mais moins optimiste par rapport à l'évolution de la biomasse.

Les importations de combustibles fossiles (pétrole, gaz naturel et charbon) diminuent par rapport au scénario de référence. Ce recul représente une économie d'environ 1,2 milliard d'euros en 2020 (en euros de 2008), soit un montant proche de celui mentionné dans le WP 21-08. En effet, dans la version actualisée de l'étude, des prix internationaux des combustibles plus élevés compense la baisse plus modérée des importations de combustibles fossiles par rapport au scénario de référence.

…sur les émissions de gaz à effet de serre

La mise en œuvre du Paquet Climat-Energie en Belgique entraîne en 2020 une réduction des émissions totales de GES de l'ordre de 14% par rapport à 2005. Les émissions du secteur ETS diminuent de 23%, les objectifs dans ce secteur sont fixés à l'échelle européenne et pas nationale. Les émissions de GES du secteur non ETS reculent d'environ 7% en 2020 par rapport au niveau de 2005. Le secteur résidentiel contribue le plus largement à cette baisse, tant en termes relatifs qu'absolus. Les mécanismes de flexibilité devraient permettre d'atteindre l'objectif de -15%.

Le tableau ci-dessous présente les principaux résultats en termes d'énergie et d'émissions pour le scénario de référence et le scénario *20/20 target*.

Synthèse des principaux résultats, comparaison entre le scénario de référence et le scénario *20/20 target* et sa variante, année 2020

			Scénario de référence	20/20 target	
				20/20	20/20_alt1
Prix	ETS	CV (€/tCO_2)	25.0	16.5	16.5
	Non-ETS	CV (€/tCO_2)	0.0	5.3	41.5
	SER	RV (€/MWh)	0.0	82.0	82.0
Quantités	Demande finale d'énergie	par rapport au scénario de référence (%)	-	-1.0	-2.0
	Demande d'électricité	Taux de croissance annuel moyen '05-'20 (%)	0.8	0.7	0.8
	GES ETS	par rapport au scénario de référence (%)	-	-14.3	-11.7
	GES Non ETS	par rapport au scénario de référence (%)	-	-5.4	-9.3
	Total GES	par rapport au scénario de référence (%)	-	-9.0	-10.3
	SER	consommation (ktep)	2752	4952	4979

Source : inputs et résultats du modèle PRIMES.

…sur le coût direct total

Le coût direct total englobe les coûts additionnels, par rapport au scénario de référence, supportés par les consommateurs belges d'énergie et liés à la réduction des émissions de GES en Belgique, aux efforts entrepris pour développer les SER et à l'achat de mécanismes de flexibilité (dans le secteur non ETS et pour les SER). Le coût direct total de la mise en œuvre du Paquet Climat-Energie est estimé à 1,2 milliard d'euros en 2020 (euros de 2008), soit 0,3% du PIB belge en 2020. Ceci représente la moitié du montant calculé dans le WP 21-08. Les dépenses liées à l'énergie constituent le principal composant du coût direct total (l'autre composant étant les « disutility cost ») et incluent l'achat d'équipement et de combustibles. Par rapport au scénario de référence, les dépenses liées à l'énergie augmenteraient de 900 millions d'euros en 2020 (euros de 2008).

Si le coût direct total est plus faible que dans le WP 21-08, c'est en partie en raison de la crise économique, des prix énergétiques plus élevés et de la mise en œuvre de mesures politiques dans le scénario de référence qui réduisent les efforts à fournir pour réduire les émissions de GES dans le secteur non ETS par rapport au WP 21-08. Citons également le fait que l'objectif européen au niveau du secteur ETS a déjà été atteint dans le scénario de référence alors que ce n'était pas le cas dans le WP 21-08.

…si une réduction plus significative des GES est exigée dans le secteur non ETS au niveau national

L'analyse du Paquet Climat-Energie a été complétée par une évaluation (scénario *20/20_alt1* dans le tableau) visant à déterminer l'impact qu'aurait une réduction plus drastique des émissions de GES dans le secteur non ETS belge. Pour cela, nous sommes partis d'une baisse de 11% en 2020 par rapport à 2005, au lieu des 7% établis dans le scénario *20/20 target*. En voici les principaux résultats : (1) limiter le recours aux mécanismes de flexibilité dans secteur non ETS favorise un glissement vers l'utilisation de l'électricité ; (2) par conséquent, on observe une réduction plus faible des émissions de GES dans le secteur ETS entre 2005 et 2020 par rapport au scénario *20/20 target* (-21% contre -23%); (3) le coût direct total augmente pour atteindre 1,4 milliard d'euros en 2020, soit un montant supérieur de 16% à celui estimé dans le scénario *20/20 target*. Les coûts supplémentaires proviennent principalement des disutility costs.

Impact d'une réduction de 30% des émissions de GES à l'échelle européenne à l'horizon 2020 …

Suivant en cela les analyses de la Commission européenne, deux scénarios de réduction de 30% des émissions de GES sont analysés dans cette étude : l'un se fonde sur une dynamique européenne interne et les mécanismes de flexibilité n'opèrent qu'entre Etats membres de l'UE (*scénario 30/20_ int target*), l'autre offre la possibilité à l'UE de rencontrer ses obligations en exploitant les mécanismes de flexibilité à concurrence de la moitié de l'effort additionnel (*scénario 30/20_flex target*). Les valeurs du carbone utilisées pour simuler ces deux scénarios sont présentées dans le premier tableau. La valeur des énergies renouvelables est supposée être la même que dans le scénario *20/20 target*.

Notez que, contrairement à l'analyse du scénario *20/20 target*, l'analyse des scénarios *30/20 target* présentée dans cette étude n'est pas directement comparable à celle décrite dans le WP 21-08 et ce, pour deux raisons. Premièrement, les deux scénarios *30/20 target* étudiés ici sont envisagés à plus long terme (2050). Tous deux sont compatibles avec un objectif de 2°C, ce qui implique, pour l'UE, une trajectoire coût-efficace de réduction des émissions de GES de 40% en 2030 et de 80% en 2050 par rapport à 1990. Deuxièmement, les effets des scénarios *30/20 target* sont décrits en comparaison avec le scénario *20/20 target* et non pas en comparaison avec le scénario de référence (comme dans le WP 21-08).

La présente synthèse met l'accent sur les résultats du scénario *30/20_flex target*. Les résultats du scénario *30/20_int target* et des variantes sont mentionnés lorsqu'ils sont pertinents.

...sur le système énergétique de la Belgique

La réduction de 30% des émissions de GES implique une nouvelle baisse de 3% de la demande finale énergétique à l'horizon 2020 en comparaison avec le scénario *20/20 target*. Les secteurs tertiaire et résidentiel sont les plus concernés par cette baisse, tant en termes relatifs qu'absolus. La baisse s'applique à la plupart des formes d'énergie, les SER constituant l'exception. En effet, la consommation finale de SER est égale au niveau projeté en 2020 dans le scénario *20/20 target*.

La demande d'électricité augmente de 0,6% par an en moyenne sur la période 2005-2020 comparé à 0,7% dans le scénario *20/20 target*. En dépit d'une légère baisse de la production d'électricité, le mix de combustibles reste pratiquement inchangé. Plus particulièrement, la part des SER dans la production d'électricité est égale à 22% en 2020 comme dans le scénario *20/20 target*.

La baisse de la demande finale énergétique, combinée au même incitant en faveur des SER (soit la même valeur des énergies renouvelables) entraîne une légère progression des SER dans la demande finale énergétique brute : 12,8% contre 12,5% dans le scénario *20/20 target*. Par conséquent, l'écart par rapport à l'objectif (13%) se réduit sensiblement, et partant, le recours aux mécanismes de coopération.

La baisse de demande finale d'énergie entraîne une diminution des importations des combustibles fossiles. En termes financiers, cela implique une économie de près de 0,5 milliard d'euros en 2020, en sus des 1,2 milliard d'euros estimés dans le scénario *20/20 target*.

Si la réduction de 30% (scénario *30/20_int target)* est réalisée uniquement au sein de l'UE, les effets décrits ci-dessus sont plus importants : on enregistre une nouvelle baisse de 5% de la demande finale d'énergie, la part des SER dans la demande énergétique finale brute passe à 13,2% et une économie supplémentaire de 0,9 milliard d'euros est engrangée suite à la baisse des importations de combustibles fossiles.

...sur les émissions de gaz à effet de serre

Les émissions totales de GES sont 5% inférieures par rapport au niveau atteint en 2020 dans le scénario *20/20 target*. La baisse atteint respectivement 5,9% et 4,7% dans les secteurs ETS et non ETS. Le secteur contribuant le plus aux nouvelles baisses d'émissions de GES en Belgique, tant en termes absolus qu'en termes relatifs, est le secteur énergétique. Il est suivi par les secteurs tertiaire et résidentiel et par les secteurs générant des émissions autres que le CO_2. La réduction de 30% des émissions de GES dans l'UE par rapport au niveau de 2005 se traduit en Belgique par une diminution de 18% des émissions totales de GES à l'horizon 2020.

Si la réduction de 30% est réalisée uniquement au sein de l'UE (scénario *30/20_int target),* les émissions totales de GES de la Belgique seraient inférieures de 9% par rapport au niveau atteint en 2020 dans le scénario *20/20 target.*

Le tableau ci-dessous résume l'impact du scénario *30/20 target* sur l'énergie et les émissions de GES.

Synthèse des principaux résultats, comparaison entre le scénario *20/20 target* et les scénarios *30/20 target* et leurs variantes, année 2020

		20/20 target	30/20_flex target		30/20_int target	
		20/20	30/20_flex	30/20_flex_alt2	30/20_int	30/20_int_alt3
Prix						
ETS	CV (€/tCO_2)	16.5	30.2	30.2	55.4	55.4
Non-ETS	CV (€/tCO_2)	5.3	30.2	50.7	55.4	82.4
SER	RV (€/MWh)	82.0	82.0	82.0	82.0	82.0
Quantités						
Demande finale d'énergie	par rapport au scénario 20/20 target (%)	-	-2.9	-4.4	-5.4	-7.0
Demande d'électricité	Taux de croissance annuel moyen '05-'20 (%)	0.7	0.6	0.5	0.5	0.5
GES ETS	par rapport au scénario 20/20 target (%)	-	-5.9	-7.3	-12.2	-12.4
GES Non-ETS	par rapport au scénario 20/20 target (%)	-	-4.7	-7.3	-7.6	-10.6
GES Totaux	par rapport au scénario 20/20 target (%)	-	-5.1	-7.3	-9.4	-11.3
SER	Consommation (ktep)	4952	4941	4929	4983	4931

Sources : Inputs et résultats du modèle PRIMES.

… sur l'économie belge

L'estimation du coût économique pour la Belgique d'une réduction de 30% des émissions de GES est réalisée par le biais de deux approches complémentaires. La première consiste en l'évaluation du coût direct de la réduction tandis que la seconde s'intéresse aux effets macroéconomiques.

Le coût direct total de la réduction de 30% des émissions de GES (soit le coût additionnel par rapport au scénario *20/20 target*) devrait approcher 0,8 million d'euros en 2020, soit 0,20% du PIB en 2020. Ce résultat s'explique par une augmentation du coût lié aux efforts intérieurs et, dans une moindre mesure, par un recours accru aux mécanismes de flexibilité dans le secteur non ETS conjugué à un recours moindre à ces mécanismes pour les SER. Il convient de faire remarquer qu'une part importante du coût additionnel consiste en des « disutility costs ». Si l'on s'en tient aux dépenses liées à l'énergie, on observe une diminution par rapport au scénario *20/20 target* (-0,9 milliard d'euros en 2020 (euros 2008)).

Si la réduction de 30% (scénario *30/20_int target*) est réalisée complètement au sein de l'UE, le coût direct total (coût additionnel comparé au scénario *20/20 target*) est estimé à 1,3 milliard d'euros en 2020, soit 0,32% du PIB en 2020. Les dépenses énergiques diminuent aussi en comparaison avec le scénario *20/20 target* (-1,6 milliard d'euros en 2020 (euros 2008), soit 0,39% du PIB).

Si, dans le cadre de l'objectif non ETS (variantes alt2 et alt3), on limite le recours aux mécanismes de flexibilité en Belgique, le coût direct total de la réduction de 30% des émissions de GES dans l'UE augmentera de respectivement 7% et 19% dans les scénarios *30/20_flex_alt2 target* et *30/20_int_alt3 target* (toutefois les dépenses énergétiques baissent de nouveau de près de 400 millions d'euros aux prix 2008 dans les deux variantes).

Puisque le coût direct n'intègre pas les effets en retour sur l'économie belge et ses secteurs, une analyse macrosectorielle a été réalisée par le biais du modèle HERMES. D'un point de vue macroéconomique, il est important de prendre en compte des modifications du comportement des différents agents et du niveau de leur demande, celles-ci étant induites par l'augmentation des coûts et des prix suite à la hausse des prix énergétiques. Il serait en outre intéressant de prendre en considération les politiques de recyclage des recettes additionnelles générées par les stratégies de réduction des émissions de GES étant donné qu'elles sont susceptibles d'avoir un impact sur le coût de production des entreprises.

Dans un souci de cohérence, plusieurs liens doivent être établis entre l'analyse basée sur le modèle PRIMES et le modèle HERMES.

Premièrement, les valeurs du carbone mentionnées ci-dessus constituent un input pour l'analyse macroéconomique. L'introduction de ces valeurs induit une augmentation des prix énergétiques qui sont notamment fonction de la teneur en CO_2 des différentes formes d'énergie (en 2020, l'augmentation moyenne des prix énergétiques dans les scénarios *30/20_flex target* et *30/20_int target* par rapport au scénario *20/20 target* atteindrait respectivement 4,7% et 9,8%). Pour le secteur ETS, la valeur du carbone peut être assimilée au prix du marché des permis d'émission dans l'UE. Pour le secteur non ETS, la valeur du carbone est une mesure monétaire du degré de réduction des émissions imposé dans ce secteur. Elle correspond au signal prix nécessaire pour déclencher la réduction des émissions correspondante par les agents économiques.

La vente aux enchères de permis d'émission génère de nouvelles recettes pour l'Etat. Le recours à des instruments générant des recettes, comme une taxe carbone, peut également générer des nouvelles recettes dans le secteur non ETS. HERMES simule deux possibilités de recyclage des recettes additionnelles générées par une politique de réduction des émissions de GES:

– Dans le cadre de '*pas de politique de recyclage*', les nouvelles recettes ne sont pas recyclées mais contribuent à réduire le déficit public.
– En revanche, dans le cadre de la '*politique à part entière de recyclage*', toutes les nouvelles recettes (ETS + non ETS) sont recyclées dans des réductions de cotisations patronales. Le recyclage à part entière est calibré pour être neutre sur le plan budgétaire, les nouvelles recettes étant exactement compensées par des réductions fiscales dans d'autres domaines.

Deuxièmement, les prix de l'électricité et la structure du parc de production électrique tirés de PRIMES servent d'input à l'analyse macroéconomique. L'objectif en matière de SER est dès lors pris en considération dans la mesure où il exerce un effet sur le secteur électrique et les valeurs du carbone.

Troisièmement, les montants payés pour les mécanismes de flexibilité sont introduits dans HERMES.

Certaines variables de l'environnement macroéconomique international ont été adaptées étant donné que les politiques de réduction des émissions de GES sont mises en œuvre dans l'ensemble de l'Europe où elles auront également un impact macroéconomique. Ces changements concernent l'évolution des prix internationaux et les marchés potentiels à l'exportation pour la Belgique. Ils ont été simulés au moyen du modèle macrosectoriel NEMESIS.

Des simulations ont été réalisées pour les scénarios *30/20 target* (*_flex* and *_int*) et leurs résultats ont été comparés avec ceux du scénario *20/20 target*. Les effets peuvent sensiblement varier selon le scénario choisi et le recyclage ou non des nouvelles recettes. Si les recettes ne sont pas recyclées, le PIB réel baisserait de 0,4% en 2020 dans le scénario *30/20_flex target* sous l'effet d'une baisse des exportations et de la demande intérieure. Cela correspond à un ralentissement de la croissance économique annuelle moyenne de 0,05 point de pourcentage sur la période 2013-2020. Cet effet serait doublé dans le scénario *30/20_int target* (-0,8% du PIB en 2020, ce qui représente un recul annuel de 0,1 point de pourcentage). Cette politique aurait également un impact négatif sur l'emploi, les pertes d'emploi à l'horizon 2020 étant évaluées à environ 24 000 dans le scénario *30/20_ flex target* et à près de 47 000 dans le scénario *30/20_int target*. Par contre, si les recettes sont recyclées à part entière, l'impact de l'augmentation des prix énergétiques sur le PIB serait beaucoup plus limité dans les deux scénarios. La baisse du PIB réel serait proche de 0,15% en 2020 dans les deux scénarios, ce qui représente un ralentissement de la croissance économique annuelle moyenne de moins de 0,02 point de pourcentage sur l'ensemble de la période de simulation. De plus, la politique de recyclage aurait un impact positif sur l'emploi sous l'effet de la réduction des charges salariales prenant la forme de réductions de cotisations patronales. Dans le scénario *30/20 flex target*, quelque 7 000 emplois supplémentaires seraient créés à l'horizon 2020 par rapport au scénario *20/20 target*. L'impact serait plus important dans le scénario *30/20_int target*, avec 25 000 nouveaux emplois créés.

Synthese

Context

Eind 2008 publiceerde het Federaal Planbureau Working Paper 21-08 (WP 21-08) waarin de impact van het Europees Klimaat- en Energiepakket op het Belgisch energiesysteem en op de Belgische economie wordt beschreven en geanalyseerd. Het vertrekpunt van die analyse was de Effectbeoordeling en haar bijlagen die door de Europese Commissie in januari 2008 werden gepubliceerd. Er werden een aantal scenario's bestudeerd waarin rekening wordt gehouden met het opvoeren van de EU-reductie-inspanning voor broeikasgasemissies tegen 2020 van 20% tot 30%. Al die scenario's werden opgesteld op basis van de best beschikbare informatie op dat ogenblik.

Ondertussen is er veel veranderd. Eerst was er de financiële en economische crisis die in het derde kwartaal van 2008 uitbrak en een aanzienlijke impact heeft gehad op het Belgisch bbp. Vanaf dan waren de macro-economische projecties dus compleet anders in vergelijking met de verwachtingen in 2007, toen de analyse werd gemaakt. Daarnaast werden de projecties van fossielebrandstoffenprijzen opwaarts herzien door de recente ontwikkelingen in de vraag naar en het aanbod aan olie en aardgas. Tot slot werden een aantal energie-efficiëntiemaatregelen goedgekeurd en in de loop van 2008 en 2009 in de wetgeving opgenomen. Al die factoren deden afbreuk aan de relevantie van de studie uit 2008, hoewel die slechts 2 jaar oud is.

Om rekening te houden met de gewijzigde situatie en verwachtingen en om te voldoen aan de verbintenis om een analyse van de 30%-reductiedoelstelling uit te voeren als antwoord op de conclusies van de Raad van maart 2010, stelde de Europese Commissie in 2010 een herzien referentiescenario voor en een actualisering van het Energie- en Klimaatpakket, alsook een analyse van opties die verder gaan dan een Europese BKG-reductie van 20% in 2020. Meer recent, in maart 2011, heeft de Europese Commissie in een nieuwe mededeling een routekaart voor een concurrerende koolstofarme economie in 2050 voorgesteld. Deze mededeling en de bijbehorende effectbeoordeling wierpen een nieuw licht op de Europese BKG-reductiedoelstelling in 2020.

Dit studierapport is gebaseerd op de nieuwe economische en beleidscontext en maakt gebruik van de analyses die de Europese Commissie heeft uitgevoerd op niveau van de EU. Het heeft dezelfde structuur als WP 21-08. Naast een referentiescenario worden ook alternatieve scenario's onderzocht: het *20/20 target*-scenario en de *30/20 target*-scenario's, die respectievelijk een BKG-emissiereductie van 20% en 30% vertegenwoordigen op EU-niveau in 2020 ten opzichte van 1990 en een Europees aandeel van 20% hernieuwbare energie (HEB) in de bruto finale energievraag in 2020. Deze studie omvat ook twee varianten die de impact ramen van grotere binnenlandse BKG-reducties in de Belgische non-ETS-sector dan in de alternatieve scenario's.

Qua modellering verschillen de scenario's en varianten in de koolstofwaarden en HEB-waarden, zoals blijkt uit de onderstaande tabel.

Overzicht van de koolstof- en hernieuwbare waarden in de verschillende scenario's en varianten, jaar 2020

	Referentie	20/20 target		30/20_flex target		30/20_int target	
		20/20	20/20_alt1	30/20_flex	30/20_flex_alt2	30/20_int	30/20_int_alt3
ETS – KW in €/tCO_2	25.0	16.5	16.5	30.2	30.2	55.4	55.4
non-ETS							
- KW in €/tCO_2	0.0	5.3	41.5	30.2	50.7	55.4	82.4
- BKG (% wijziging 2005-2020)	-1.9	-7.2	-11.0	-11.5	-14.0	-14.3	-17.0
HEB							
- HW in €/MWh	0.0	82.0	82.0	82.0	82.0	82.0	82.0
- Aandeel in BFEV (%)	6.9	12.5	12.6	12.8	13.0	13.2	13.3

KW = koolstofwaarde; HW = hernieuwbare waarde.
BFEV = Bruto finale energievraag.

Deze studie omvat de analyse van de impact van elk scenario (of variant) op het Belgische energiesysteem, de BKG-emissies en de directe aanpassingskosten (op basis van het PRIMES-model en resultaten van het GAINS-model) en integreert een verdere analyse van de bredere macro-economische impact van het opvoeren van de reductie-inspanning tot -30% (op basis van het HERMES-model).

Impact van het wetgevend Klimaat- en Energiepakket…

…op het Belgisch energiesysteem

De nieuwe analyse bevestigt de resultaten van WP 21-08: energiebesparingen en HEB-gebruik zijn de voornaamste antwoorden van het Belgisch energiesysteem op de doelstellingen. In vergelijking met het referentiescenario, is de omvang van de energiebesparingen nochtans geringer dan in WP 21-08. In 2020 daalt de finale energievraag minder t.o.v. het referentiescenario: 1% tegenover bijna 6% in WP 21-08. De neerwaarts herziene vooruitzichten voor de economische groei als gevolg van de economische en financiële crisis zorgen ervoor dat de BKG-reductiedoelstelling gemakkelijker bereikt kan worden, d.w.z. dat er minder energiebesparingen nodig zijn t.o.v. het referentiescenario. De finale energievraag zou schommelen rond 39 Mtoe in 2020 (tegenover 38,4 Mtoe in 2005) in het *20/20 target* scenario, d.w.z. de jaarlijkse gemiddelde groei bedraagt 0,1% over de periode 2005-2020. Relatief gezien zijn de energiebesparingen het grootst in de tertiaire sector en het kleinst in de industrie; energiebesparingen hebben betrekking op alle energievormen behalve HEB.

Het HEB-aandeel is daarentegen vergelijkbaar in beide studies: ongeveer 5 Mtoe (of 57 TWh) in 2020. Dat niveau vertegenwoordigt een aandeel van 12,5% van de bruto finale energievraag. Het tekort ten aanzien van de 13%-doelstelling voor België wordt gecompenseerd door samenwerkingsmechanismen.

De vraag naar elektriciteit stijgt gemiddeld met 0,7% per jaar tussen 2005 en 2020 in vergelijking met 0,8% in het referentiescenario en 1,3% in het vorige *20/20 target* scenario. De lagere groeivoeten in deze update weerspiegelen de economische terugval en het effect van maatregelen en beleid zoals de Ecodesign en labelrichtlijnen. Het HEB-aandeel in stroomopwekking zou ongeveer 22% bedragen, tegenover 19% in WP 21-08 en 15% in het nieuwe referentiescenario. De toename van de elektriciteitsproductie op basis van hernieuwbare energie gebeurt ten nadele van steenkool en aardgas. Bovendien is de nieuwe studie in vergelijking 'meer optimistisch' wat betreft de ontwikkeling van windenergie- en fotovoltaïsche zonne-energiecapaciteit, maar lichtjes 'minder optimistisch' wat betreft biomassacapaciteit.

De import van alle fossiele brandstoffen (olie, aardgas en steenkool) daalt ten opzichte van het referentiescenario. Uitgedrukt in monetaire termen komt die daling overeen met een besparing van ongeveer 1,2 miljard euro in 2020 (in euro van 2008). Dat cijfer is van dezelfde grootteorde als dat in WP 21-08: in de actualisering compenseren hogere internationale brandstofprijzen een relatief lagere terugval van de invoer van fossiele brandstoffen in vergelijking met het referentiescenario.

... op de broeikasgasemissies

De tenuitvoerlegging van het wetgevend Klimaat- en Energiepakket in België leidt tot een binnenlandse daling van de totale broeikasgasemissies met 19% in 2020 in vergelijking met 2005. In de ETS-sector dalen de BKG-emissies met 23%. De evolutie van de uitstoot voor die sector wordt geregeld op EU-niveau en er gelden geen nationale doelstellingen. In de non-ETS-sector dalen de broeikasgassen met ongeveer 7% in 2020 ten opzichte van 2005. De residentiële sector doet de voornaamste bijdrage tot die neerwaartse trend, zowel in relatieve als absolute termen. De toegang tot de flexibiliteitsmechanismen wordt verondersteld de kloof ten opzichte van de -15%-doelstelling te dichten.

Onderstaande tabel geeft een overzicht van de voornaamste resultaten inzake energie en BKG-emissie voor het referentiescenario en het *20/20 target*-scenario met diens variant.

Overzicht van de voornaamste resultaten, vergelijking tussen het referentiescenario en het *20/20 target*-scenario en variant, jaar 2020

			Referentiescenario	20/20 target	
				20/20	20/20_alt1
Prijzen	ETS	KW (€/tCO_2)	25.0	16.5	16.5
	Non-ETS	KW (€/tCO_2)	0.0	5.3	41.5
	HEB	HW (€/MWh)	0.0	82.0	82.0
Hoeveelheden	FEV	tov referentiescenario (%)	-	-1.0	-2.0
	Elek. vraag	gemiddelde jaarlijkse groei '05-'20 (%)	0.8	0.7	0.8
	ETS BKG	tov referentiescenario (%)	-	-14.3	-11.7
	Non-ETS BKG	tov referentiescenario (%)	-	-5.4	-9.3
	Totaal BKG	tov referentiescenario (%)	-	-9.0	-10.3
	HEB	consumptie (ktoe)	2752	4952	4979

KW = koolstofwaarde; HW = hernieuwbare waarde; tov = ten opzichte van.
FEV = finale energievraag.
Bron: input en resultaten PRIMES.

... op de totale directe kosten

De totale directe kosten omvatten de bijkomende kosten, ten opzichte van het referentiescenario, die de Belgische energieconsumenten gewaarworden en die verband houden met zowel de binnenlandse inspanningen voor broeikasgasmitigatie en HEB-productie als de aankoop van flexibiliteit (in de non-ETS-sector en voor HEB). De totale directe kosten voor de uitvoering van het wetgevend Klimaat- en Energiepakket worden geraamd op 1,2 miljard euro in 2020 (in euro van 2008) of 0,3% van het Belgisch bbp in 2020. Dat is ongeveer de helft van het bedrag uit WP 21-08. De energiegebonden uitgaven vormen de voornaamste component van de totale directe kosten (de 'disutility' kosten vormen de andere component). Ze omvatten de kosten voor de aankoop van uitrusting en brandstof. Vergeleken met het referentiescenario, stijgen de energiegebonden uitgaven met 900 miljoen euro in 2020 (in euro van 2008).

De lagere raming van de totale directe kosten is deels te wijten aan de economische crisis, hogere internationale energieprijzen en doorgevoerde beleidsmaatregelen in het referentiescenario die de reductie-inspanning voor broeikasgasemissies in de non-ETS-sector verminderen ten opzichte van WP 21-08. Een ander deel van de verklaring ligt in het feit dat de EU-ETS-doelstelling reeds in het referentiescenario wordt bereikt, wat niet geval was in het referentiescenario in WP 21-08.

… indien er grotere binnenlandse BKG-reducties vereist zijn in de non-ETS-sector

De analyse van het Europees Klimaat- en Energiepakket werd aangevuld (*20/20_alt1* scenario in de tabel) met een beoordeling van de impact van het opleggen van grotere BKG-reducties aan de Belgische non-ETS-sector, namelijk 11% in 2020 ten opzichte van 2005, in plaats van 7% in het *20/20 target*-scenario. De voornaamste resultaten van die beoordeling zijn de volgende: (1) de beperking van de flexibiliteit in de non-ETS-sector bevordert de substitutie van brandstof door elektriciteit; (2) bijgevolg worden de BKG-emissies in de ETS tussen 2005 en 2020 minder verlaagd dan in het 20/20 *target*-scenario (-21% tegenover -23%); (3) de totale directe kosten stijgen tot 1,4 miljard euro in 2020, of 16% meer dan de totale directe kosten in het *20/20 target*- scenario. De bijkomende kosten zijn hoofdzakelijk toe te schrijven aan de 'disutility' kosten.

Impact van een opvoering van de BKG-reductiedoelstelling tot -30% op EU-niveau in 2020…

Vergelijkbaar met de analyses van de Europese Commissie, worden in deze studie twee -30%-scenario's bestudeerd: het eerste scenario veronderstelt een volledig, intern antwoord van de EU op de opvoering en flexibiliteit die enkel plaatsvindt tussen de EU-lidstaten (*30/20_int target*-scenario); het tweede scenario gaat ervan uit dat de EU haar verplichtingen nakomt, met de mogelijkheid om gebruik te maken van flexibiliteitsmechanismen voor de helft van de bijkomende inspanning (*30/20_flex target*-scenario*)*. De koolstofwaarden (KW) die nodig zijn om deze twee scenario's te simuleren, worden vermeld in de eerste tabel. De hernieuwbare waarde wordt verondersteld dezelfde te zijn als in het *20/20 target*-scenario.

In tegenstelling tot de analyse van het *20/20 target*-scenario, is de analyse van de *30/20 target*-scenario's die voor deze studie ontwikkeld werden niet vergelijkbaar met die van WP 21-08, om twee redenen. Allereerst zijn de twee *30/20 target*-scenario's ontworpen binnen een langer termijnperspectief (2050). Dat wil zeggen dat ze beiden verenigbaar zijn met de 2°C-doelstelling, die zich voor EU vertaalt in een kostenefficiënt traject voor de vermindering van BKG-emissies met 40% in 2030 en 80% in 2050 (ten opzichte van 1990). Ten tweede wordt de impact van de *30/20 target*-scenario's beschreven in vergelijking met het *20/20 target*-scenario en dus niet in vergelijking met het referentiescenario (zoals in WP 21-08).

In deze synthese ligt de nadruk op de resultaten van het *30/20_flex target*-scenario. Indien relevant, worden de resultaten van het *30/20_int target*-scenario en de varianten vermeld.

… op het Belgisch energiesysteem

De opvoering naar -30% leidt tot een verdere vermindering van de finale energievraag met 3% in 2020, ten opzichte van het *20/20 target*-scenario. De tertiaire en residentiële sectoren ondervinden de grootste impact, zowel in relatieve als absolute termen. De meeste energievormen worden teruggeschroefd. De enige uitzondering is HEB, waarvan het finaal verbruik gelijk blijft aan het niveau in het *20/20 target*-scenario in 2020.

De elektriciteitsvraag groeit gemiddeld met 0,6 % per jaar over de periode 2005-2020, tegenover 0,7% in het *20/20 target*-scenario. Ondanks een kleine daling in de energieproductie wordt de brandstofmix weinig beïnvloed. Meer bepaald bedraagt het aandeel van HEB in de energie-opwekking 22% in 2020, net zoals in het *20/20 target*-scenario.

De terugval van de finale energievraag, gecombineerd met dezelfde impuls voor HEB (d.w.z. dezelfde hernieuwbare waarde), leidt tot een lichtjes hoger aandeel van HEB in de bruto finale energievraag: 12,8% tegenover 12,5% in het *20/20 target*-scenario. Bijgevolg verkleint de kloof ten opzichte van de doelstelling (13%) en dus ook het gebruik van de samenwerkingsmechanismen.

De impact op de finale energievraag vertaalt zich in een verminderde invoer van fossiele brandstoffen. In monetaire termen betekent dat een besparing van ongeveer 0,5 miljard euro in 2020, bovenop de besparing van 1,2 miljard euro in het *20/20 target*-scenario.

In het geval van een volledig, intern antwoord van de EU op de opvoering tot -30% (*30/20_int target*-scenario) worden de voornoemde gevolgen sterker: de verdere reductie van de finale energievraag wordt 5%, het aandeel van HEB in de bruto finale energievraag 13,2% en de besparing door de daling van de invoer van fossiele brandstoffen 0,9 miljard euro.

…op de broeikasgasemissies

De totale BKG-emissies liggen 5% lager dan het niveau in het *20/20 target*-scenario in 2020. De reductiepercentages bedragen respectievelijk 5,9% en 4,7% in de ETS-sector en de non-ETS-sector. De energiesector levert de grootste bijdrage tot de verdere verlaging van BKG-emissies in België, zowel in absolute als relatieve termen, gevolgd door de tertiaire en de residentiële sector en de sectoren die verantwoordelijk zijn voor niet-CO_2-emissies. Ten opzichte van het niveau in 2005, leidt de opvoering naar -30% voor België tot een vermindering van de totale BKG-emissies met 18% in 2020.

In het geval van een volledig, intern antwoord van de EU op de opvoering naar -30% (*30/20_int target*-scenario), worden de totale Belgische BKG-emissies verondersteld 9% lager te liggen dan in het *20/20 target*-scenario in 2020.

Bij wijze van samenvatting van de impact van de *30/20 target*-scenario's op energie en emissies, biedt de volgende tabel een bondige selectie van resultaten.

Overzicht van de voornaamste resultaten, vergelijking tussen de scenario's 20/20 target en 30/20 target en varianten, jaar 2020

		20/20 target	30/20_flex target		30/20_int target	
		20/20	30/20_flex	30/20_flex_alt2	30/20_int	30/20_int_alt3
Prijzen						
ETS	KW (€/tCO_2)	16.5	30.2	30.2	55.4	55.4
Non-ETS	KW (€/tCO_2)	5.3	30.2	50.7	55.4	82.4
HEB	HW (€/MWh)	82.0	82.0	82.0	82.0	82.0
Hoeveelheden						
FEV	tov 20/20 target (%)	-	-2.9	-4.4	-5.4	-7.0
Elek. vraag	gemiddelde jaarlijkse groei '05-'20 (%)	0.7	0.6	0.5	0.5	0.5
ETS BKG	tov 20/20 target (%)	-	-5.9	-7.3	-12.2	-12.4
Non-ETS BKG	tov 20/20 target (%)	-	-4.7	-7.3	-7.6	-10.6
Totaal BKG	tov 20/20 target (%)	-	-5.1	-7.3	-9.4	-11.3
HEB	consumptie (ktoe)	4952	4941	4929	4983	4931

KW = koolstofwaarde; HW = hernieuwbare waarde; tov = ten opzichte van.
FEV = finale energievraag.
Bron: input en resultaten PRIMES.

…op de Belgische economie

De economische kosten voor België om de reductiedoelstelling op te voeren tot -30% worden ingeschat via twee aanvullende benaderingen. De eerste benadering berekent de directe kosten. De tweede benadering becijfert de macro-economische impact.

De totale directe kosten van het opdrijven van de doelstelling tot -30% (d.w.z. de bijkomende kosten vergeleken met het *20/20 target*-scenario) zouden ongeveer 0,8 miljard € bedragen in 2020, of 0,20% van het bbp in 2020. Dat is het resultaat van een toename van de kosten die verband houden met de binnenlandse inspanning en, in mindere mate, met een toename van de aankoop van flexibiliteit in de non-ETS-sector en een daling van de aankoop van HEB-flexibiliteit. Er moet worden onderstreept dat een groot deel van de bijkomende kosten te wijten is aan 'disutility' kosten. Indien men enkel rekening houdt met energiegebonden uitgaven tonen de resultaten van het model een daling t.o.v. het *20/20 target*-scenario (-0,9 miljard in euro van 2008 in 2020).

In het geval van een volledig, intern antwoord van de EU op het opvoeren tot -30% (*30/20_int target*-scenario), zouden de totale directe kosten (d.w.z. de bijkomende kosten vergeleken met het *20/20 target*-scenario) 1,3 miljard euro bedragen in 2020, of 0,32% van het bbp in 2020. De energiegebonden uitgaven dalen ook hier t.o.v. het *20/20 target* scenario (-1,6 miljard in euro 2008 in 2020, of 0,39% van het bbp).

Het instellen van een beperking op het gebruik van flexibiliteitsmechanismen in België om de non-ETS-doelstelling te bereiken (varianten *alt2* en *alt3*), heeft een impact op de totale directe kosten van het opvoeren van de reductiedoelstelling tot -30%: in 2020, zouden deze laatste stijgen met respectievelijk 7% en 19% in het *30/20_flex_alt2 target* en *30/20_int_alt3 target* scenario (de energiegebonden uitgaven zouden echter verder dalen met ongeveer 400 miljoen in euro 2008 in beide varianten).

Aangezien de directe kosten geen rekening houden met de terugverdieneffecten voor de Belgische economie en haar sectoren, werd een macro-economische analyse uitgevoerd met het HERMES-model. Vanuit macro-economisch oogpunt moet immers rekening worden gehouden met de gedragswijzigingen van de economische actoren en het niveau van hun respectievelijke vraag als gevolg van de hogere kosten en prijzen door de stijging van de energieprijzen. Bovendien is het interessant een beleid te beschouwen dat de bijkomende overheidsontvangsten afkomstig uit de toepassing van BKG-emissiereductiestrategieën opnieuw in de economie injecteert, aangezien die een impact kunnen hebben op de productiekosten van de ondernemingen.

Er zijn verschillende links nodig tussen de PRIMES-analyse en het HERMES-model om de analyse samenhangend te maken.

Ten eerste vormen de bovenvermelde koolstofwaarden een input voor de macro-economische analyse. De introductie van de koolstofwaarden leidt tot een stijging van de energieprijzen die onder meer afhangen van de CO_2-inhoud van de verschillende energievormen (in 2020 zou de gemiddelde stijging van de energieprijzen van het *30/20_flex target* scenario en van het *30/20_int target* scenario t.o.v. het *20/20 target* scenario respectievelijk 4,7% en 9,8% bedragen). Voor de ETS-sector kan de koolstofwaarde geïnterpreteerd worden als de prijs van de EU-emissierechten op de markt. Voor de non-ETS-sector is de koolstofwaarde een in geld uitgedrukte maatstaf van de strengheid van de emissiereductieverplichtingen in deze sector die moet beschouwd worden als het prijssignaal dat nodig is om de overeenkomstige emissiereducties bij de economische agenten tot stand te brengen.

De veiling van ETS-emissierechten in de EU zorgt voor nieuwe overheidsinkomsten voor het land. Bijkomende ontvangsten kunnen ook gehaald worden uit de non-ETS-sector als de regering erin slaagt in deze sector inkomstengenererende instrumenten toe te passen, zoals een koolstoftaks. HERMES simuleert twee gevallen die betrekking hebben op de herbestemming van die bijkomende overheidsontvangsten afkomstig uit een BKG-reductiebeleid:

– Geen herbestemmingsbeleid: de nieuwe overheidsontvangsten worden niet hergebruikt maar worden aangewend om de overheidsschuld te verminderen.
– Volledig herbestemmingsbeleid: alle bijkomende overheidsontvangsten (ETS + non-ETS) worden hergebruikt in de vorm van verminderingen van de sociale bijdragen die betaald worden door de werkgevers. De volledige herbestemmingsoptie is fiscaal neutraal voor de overheid, wat betekent dat de nieuwe overheidsontvangsten exact gecompenseerd worden door belastingverminderingen in andere domeinen.

Ten tweede worden de toekomstige elektriciteitsprijzen alsook de structuur van het elektriciteitsproductiepark uit PRIMES gebruikt als input voor de macro-economische analyse. De HEB-doelstelling wordt dus in aanmerking genomen voor zover ze een impact heeft op de elektriciteitssector en op de koolstofwaarden.

Ten derde, worden de betaalde bedragen met betrekking tot de toegestane flexibiliteit ingevoerd in HERMES.

Sommige variabelen die verband houden met de macro-economische internationale omgeving werden aangepast aangezien BKG-emissiereductiemaatregelen in geheel Europa worden doorgevoerd, waar ze ook macro-economische gevolgen zullen hebben. Die veranderingen hebben betrekking op de evolutie van de internationale prijzen en de potentiële exportmarkten voor België en werden gesimuleerd aan de hand van het Europese macrosectorale NEMESIS-model.

Er werden simulaties gemaakt voor beide *30/20 target*-scenario's (*_flex* en *_int*) en de resultaten werden vergeleken met die van het *20/20 target*-scenario. De impact kan vrij veel verschillen afhankelijk van het gekozen flexibiliteitsscenario en van het feit of de nieuwe overheidsinkomsten hergebruikt worden of niet. Indien dat niet het geval is, zou het reëel bbp verminderen met 0,4% in 2020 in het *30/20_flex target*-scenario, als gevolg van een dalende export en een terugval van de binnenlandse vraag. Dat komt overeen met een daling van de gemiddelde jaarlijkse groei van ongeveer 0,05 procentpunt tijdens de periode 2013-2020. Dat effect zou verdubbelen in het *30/20_int target*-scenario (-0,8% van het bbp in 2020, of een gemiddeld jaarlijks verlies van 0,1%). De werkgelegenheid zou ook negatief beïnvloed worden door het beleid, met een verlies van ongeveer 24 000 arbeidsplaatsen in 2020 in het *30/20_flex target*-scenario en bijna 47 000 arbeidsplaatsen in het *30/20_int target*-scenario. Anderzijds bij een 'volledige herbestemming' van de nieuwe overheidsontvangsten zou de impact op het bbp van de stijging van de energieprijzen veel beperkter zijn in beide scenario's. De daling van het reëel bbp zou bijna 0,15% bedragen in 2020 in beide gevallen, of een daling van de jaarlijkse gemiddelde economische groei van minder dan 0,02 procentpunt tijdens de simulatieperiode. Bovendien zou het 'volledig herbestemmingsbeleid' een positief effect hebben op de werkgelegenheid dankzij de daling van de loonkosten per werknemer als gevolg van de vermindering van de sociale bijdragen betaald door de werkgevers. In het *30/20_flex target*-scenario zouden ongeveer 7 000 extra arbeidsplaatsen gecreëerd worden bovenop die uit het *20/20 target*-scenario in 2020. De impact zou nog groter zijn in het *30/20_int target*-scenario, met ongeveer 25 000 extra arbeidsplaatsen.

Table of contents

List of tables

List of figures

1. Introduction

1.1. Context

End of 2008, the Federal Planning Bureau published the Working Paper 21-08 (Bossier et al., 2008). This Working Paper described and analysed the impact of the EU Energy-Climate Package on the Belgian energy system and economy. The starting point of the analysis was the Impact Assessment and its annexes released by the European Commission in January 2008. Some scenarios were studied taking the stepping up of the EU effort of a 20% reduction in greenhouse gas emissions by 2020 to a 30% decrease into account. All these scenarios were designed based on best available knowledge at the time.

Meanwhile, a lot has changed. First and foremost, the financial and economic crisis breaking loose in the third quarter of 2008 has had a non-negligible impact on nations' GDP. Hence, macroeconomic projections since changed radically compared to what could be expected in 2007, the time of the analysis[1]. In addition, recent developments in the field of oil and gas made fossil fuel price projections to be revised upwards. Finally, a number of energy efficiency measures were agreed upon and put into law in the EU in the course of 2008 and 2009. All this made the 2007 baseline less relevant whilst only 2 years old. To take into account the changed outset and expectations and to honour the commitment of a -30% analysis in response to the March 2010 Council conclusions, the Commission came up with a revised baseline and an update of the package study, as well as an analysis of options to move beyond a 20% European GHG reduction in 2020. These can be found in the publication *EU energy trends to 2030-update 2009* (September 2010) as well as in the Commission Staff Working Document of May 2010, accompanying the communication from the Commission *Analysis of options to move beyond 20% greenhouse gas emission reductions and assessing the risk of carbon leakage.* More recently, in March 2011, the European Commission released a communication presenting a *Roadmap for moving to a competitive low carbon economy in 2050*. This communication and its accompanying impact assessment throw new light upon the EU GHG reduction target in 2020. On top of the analysis on how to achieve 80% domestic reduction in GHG emissions in the EU by 2050, both documents elaborate on the intermediary stages towards reaching this target.

1.2. Objectives

Having noticed the changed outset and eager to find out what would be the impact of the 20 to 30% European upgrade in GHG target on Belgium's economic and energy system by following the analysis adopted in the Commission Staff Working Document SEC(2010) 650, the Belgian federal authority decided to mandate the FPB to provide an update of the WP 21-08.

At the outset, the study had a number of specific objectives, being

– To update the study of '20% GHG reduction' scenarios that aim to simulate the impact of the EU Climate-Energy Package adopted in December 2008 on the Belgian energy system and economy,

[1] Although the publication date of the WP 21-08 was end of 2008, the study started in 2007 and some major analyses as well as the definition of several assumptions took place in 2007. Also, the elaboration of the *European Energy and Transport: Trends to 2030-update 2007*, the publication that contains the 2007 baseline for Belgium, took place in 2007.

taking the new economic and energy policy context into account. Two 20% GHG reduction scenarios are investigated, differing in the amount of flexibility used to achieve the national target. They are both inspired by the Reference scenario as defined and analysed in *EU energy trends to 2030-update 2009* (from p. 35 onwards).

– To examine the '30% GHG reduction' scenarios that aim to assess the impact of moving from the 20% GHG reduction target specified in the Climate-Energy Package to a 30% GHG reduction target at EU level in 2020 compared to the 1990 level. Also for the -30% case, more than one scenario was designed differing in the amount of flexibility in both ETS and non-ETS sectors.

2. Methodology and key assumptions

This study aims at elaborating and analysing target scenarios for greenhouse gas emissions (GHG) and renewable energy sources (RES) for Belgium in a European context. The design of the target scenarios is inspired by the analysis of options to move beyond 20% GHG emission reductions issued by the European Commission in June 2010 (COM(2010) 265/3).

The analysis of the European Commission starts with the description of two scenarios: the baseline and the Reference scenario. The baseline simulates current trends and policies as implemented in the EU by spring 2009 while the Reference scenario assumes the full implementation of the Climate-Energy legislative Package[2]. The Reference scenario supposes full flexibility in achieving the GHG emission reduction target in the non-ETS sectors but assumes only a limited flexibility as regards to the RES target according to the information provided by the MS in the forecast documents forwarded to the EC in December 2009. No additional policies and measures or targets are considered beyond 2020.

The EC analysis switches then to the study of two more ambitious GHG target scenarios aiming at reducing GHG emissions at EU level by 30% in 2020 (instead of 20% in the Reference scenario). One scenario assumes that the EU settles its obligations making use of flexibility mechanisms in the order of 5 percentage points of the target (realising 25% of the reduction internally), the other counts on a complete internal EU response to the presented challenges and flexibility only takes place between the European Union's Member States (not outside). These two scenarios are more ambitious than the Reference scenario not only regarding the GHG reduction constraint in 2020 but also in a longer term perspective (2050). Both scenarios are consistent with the cost-efficient pathway described in the *Roadmap for moving to a competitive low-carbon economy in 2050*, which translates, for the EU, into a reduction of domestic GHG emissions of around 40% and 80% below 1990 in 2030 and 2050 respectively.

2.1. Methodology

2.1.1. Scenario description

The present study involves the same set of scenarios but the analysis focuses on Belgium and additional scenarios are elaborated whose aim it is to evaluate the sensitivity of the results to the assumptions made in the analysis of the European Commission. Next to the *baseline* (chapter 3), target scenarios are being scrutinized: the *20/20 target scenario* comprising a 20% EU GHG reduction and 20% EU RES development by 2020 (chapter 4), the *30/20_flex target* scenario for a 30% GHG reduction with external flexibility and 20% EU RES development by 2020 (chapter 5.1) and the *30/20_int target* scenario for a 30% EU GHG reduction without additional external flexibility and 20% EU RES development by 2020 (chapter 5.2). In these chapters, target scenarios are analysed up to the year 2020.

In order to account for the EU context, carbon and renewable values characterizing these four scenarios are taken from the analysis described in COM(2010) 265/3. They are reported in Table 1 below.

2 The legislative EU Climate-Energy Package integrates both GHG and RES targets; it does not cope with the 20% energy efficiency target at EU level.

Table 1: Overview of carbon and renewable values in the different scenarios, year 2020

	Baseline	20/20 target		30/20_flex target		30/20_int target	
		20/20	20/20_alt1	30/20_flex	30/20_flex_alt2	30/20_int	30/20_int_alt3
ETS – CV in €/tCO_2	25.0	16.5	16.5	30.2	30.2	55.4	55.4
non-ETS							
- CV in €/tCO_2	0.0	5.3	41.5	30.2	50.7	55.4	82.4
- GHG (% change 2005-2020)	-1.9	-7.2	-11.0	-11.5	-14.0	-14.3	-17.0
RES							
- RV in €/MWh	0.0	82.0	82.0	82.0	82.0	82.0	82.0
- Share in GFED (%)	6.9	12.5	12.6	12.8	13.0	13.2	13.3

CV = carbon value; RV = renewable value.
GFED = Gross Final Energy Demand.

In the *20/20 target* scenario, about half of the GHG emission reduction target for Belgium in the non-ETS sector (i.e. -15%) is achieved internally. This means that Belgium should make intense use of flexibility mechanisms to meet its target. In this context, an alternative scenario (*20/20_alt1*) was designed in which Belgium achieves more reductions internally in the non-ETS sector, namely 11%. The carbon value associated with this scenario is 41.5 €/t CO_2[3].

Similarly, alternative scenarios *30/20_flex_alt2* and *30/20_int_alt3* assume less recourse to flexibility mechanisms in the non-ETS or, the other way around, more GHG emission reductions in Belgium.

The analysis of the *20/20 target* scenario is made with respect to the *baseline*. By contrast, the analysis of the *30/20 target* scenarios is made with respect to the *20/20 target* scenario as the main objective of the study is to evaluate the impact of moving from the 20% GHG emission reduction target according to the Climate-Energy legislative Package (i.e. *20/20 target* scenario) to a 30% reduction target at EU level. Nevertheless, annex 6.1 provides detailed energy figures for each scenario allowing the assessment of changes in the *30/20 target* scenarios with respect to the *baseline*.

2.1.2. Modelling approach

The evaluation of the target scenarios follows a two stage modelling approach. In the first stage, the focus is on the impact on the Belgian energy system and on abatement costs, using the PRIMES model developed by ICCS/NTUA and results from the GAINS model of IIASA (for non-CO_2 GHG). In the second stage, the HERMES model of the FPB is used to assess the macro-economic impact of these target scenarios.

Reducing GHG emissions and developing renewable energy have an impact on the evolution of the (Belgian) energy system, not only on the structure and quantity of energy needs but also on the technological choices for energy production and consumption. In order to evaluate this impact the energy model PRIMES-BE is used. The PRIMES model covers the energy and process related CO_2 emissions.

3 It might look surprising that the reduction in the non-ETS sector is lower in the *20/20_alt1* than in the *30/20_flex* scenario, notwithstanding a more significant carbon value in the former. This has to do with the design of the scenarios: in the *20/20* scenarios, no GHG target is fixed beyond the year 2020, policies and measures of the Package are simply prolonged whilst in the *30/20* scenarios, a particular GHG reduction target is specified for the year 2030 on EU27 level, being 40% conform the June 2010 Communication (Annex II). In the *30/20* scenarios, the energy systems then anticipate the more stringent future target and adapt accordingly. This explains why, for a seemingly equal percentage reduction, the carbon value will be less significant in the *30/20_flex* scenario.

Non-CO_2 GHG reduction possibilities are identified through the marginal abatement cost curves calculated with the GAINS model. These cost curves are defined per type of non-CO_2 GHG (i.e. CH_4, NO_2 and F-gases) and per country. These curves, along with CO_2 reduction possibilities quantified through the PRIMES model, are combined for constructing the GHG and RES target scenarios.

From a macroeconomic perspective, it is needed to take into account the changes in agents' behaviour and demand level resulting from the rise in costs and in prices implied by the higher energy prices. What is more, recycling policies of the additional public revenues generated by the implementation of GHG emission reduction strategies are interesting to consider, which could have impacts on the firms' production cost. To account for these feedback effects, the macro-sectoral model HERMES[4] was used.

Several links are required between the PRIMES-based analysis and the HERMES model to make the analysis consistent. First of all, HERMES takes as an input the carbon values calculated by the PRIMES model for each flexibility scenario. The introduction of the carbon values implies an increase in energy prices depending, among others, on the CO_2 content of the various energy forms. For the ETS sector, the carbon value can be interpreted as the price of the EU allowances on the market. For the non-ETS sector, the carbon value is a measure in monetary terms of the stringency of the emission reduction constraints in this sector. It has to be considered as the price-signal needed to induce the corresponding emission reduction by the economic agents. Although it is supposed to reflect any kind of emission reduction policy or measure, in HERMES, it corresponds to the implementation of one or several revenue-generating policies, such as a carbon tax.

The auction of EU ETS allowances provides new public revenues for the country. Additional receipts may also be captured in the non-ETS sector if the government succeeds in implementing revenue-generating instruments, such as a carbon tax, in this sector. HERMES simulates two cases regarding the recycling of those additional public receipts generated by a GHG reduction policy:

- No recycling policy: the new public revenues are not recycled but are used to reduce public debt.
- Full recycling policy: all additional public revenues (ETS + non-ETS) are recycled in reductions of social contributions paid by employers. The full recycling option is calibrated to be tax neutral for the public authorities[5], meaning that the new public revenues generated are exactly offset by tax reductions elsewhere.

The second type of PRIMES output used as an input in the HERMES simulations are the future electricity prices as well as the structure of the electricity production park. The RES target is therefore taken into account to the extent that it has an impact on the electricity sector and on the carbon values.

Thirdly, the amounts paid regarding the flexibility allowed are introduced in HERMES.

Some variables related to the macroeconomic international environment had to be adjusted in HERMES since GHG emission reduction policies take place in Europe as a whole, where it will have macroeconomic impacts as well. Those changes concern the evolution of international prices and the potential

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4 Version of October 2010. For a full description of the HERMES model see e.g. the Working Paper 5-04, downloadable on http://www.plan.be/publications/Publication_det.php?lang=fr&TM=48&IS=63&KeyPub=140.

5 Whereas the first policy option is not tax neutral.

export markets for Belgium and were simulated by means of the European macro-sectoral model NEMESIS[6].

2.2. Key assumptions

In order to elaborate long term energy projections, it is indispensable to start with the stipulation of a number of hypotheses. The hypotheses used in this exercise relate to a number of variables, e.g. international fuel prices, economic activity, demography and the implemented policy measures. They are briefly described below.

More information, in particular on assumptions that are not Belgium specific but relate to the European policy context or international framework, can be found in the publication *EU energy and transport trends to 2030 – update* 2009 (European Commission, DG ENER), in the Commission Staff Working Document SEC(2010) 650 of May 2010 accompanying the communication from the Commission *Analysis of options to move beyond 20% greenhouse gas emission reductions and assessing the risk of carbon leakage* and in the Commission Staff Working Document SEC(2011) 288 of March 2011 accompanying the communication from the Commission *A Roadmap for moving to a competitive low carbon economy in 2050*.

2.2.1. Economic activity, demography and international energy prices

In 2008 and 2009, Member States' economic activity was affected by the financial and economic crisis. It is important to take this downturn into account (which wasn't the case in WP 21-08) in the macroeconomic outlook for the different Member States. It is also important to look at what will happen after the crisis: Will the economy recover completely and make up for its loss? Will it grow but never restore the damage?

For the 2009 Commission exercise, GDP projections for the short term (2009-2010) mirror economic forecasts from DG ECFIN (European Economy, May 2009), which complement the up-to-date statistics for 2005-2008 from Eurostat[7]. The medium term (2010-2020) growth projections of GDP and sectoral value added are based on FPB's medium term economic forecasts published in May 2009 (Federal Planning Bureau, May 2009). Finally, the long term growth projections follow the baseline scenario of the 2009 Ageing Report (European Economy, April 2009). This 2009 Ageing report was established with the support of Member States' experts by DG ECFIN and the Economic Policy Committee and was then endorsed by the ECOFIN Council.

The *baseline* assumes that the recent economic crisis has long lasting effects leading to a permanent loss in GDP. The recovery from the crisis is not expected to be vigorous enough to compensate for lower GDP growth rates during the crisis. Consequently, GDP in 2020 and 2030 is significantly lower than could have been expected without the crisis (hence in WP 21-08).

Next to that, revised population prospects became available. These are made up for the entire EU27

[6] For a full description of the NEMESIS model, see the "NEMESIS Reference Manual", downloadable on http://www.erasme-team.eu/index.php/erasme-nemesis/41-overview/73-the-nemesis-reference-manual.html

[7] The Eurostat statistics for the years 2006, 2007 and 2008 are rather for information on assessments and do not constitute a model input.

and are based on the EUROPOP2008 convergence scenario from Eurostat, which also forms the basis for the 2009 Ageing Report. Notwithstanding the fact that these prospects diverge slightly from the latest FPB/DG SIE demographic forecasts (FPB, April 2008), the general trends are similar. In comparison to WP 21-08, projections are higher due to different migration assumptions.

International energy prices are substantially higher than in WP 21-08. Oil prices are expected to reach 88$ in 2020 and 106$ in 2030, expressed in 2008 prices. WP 21-08 worked with 65$/barrel in 2020 and 66$ in 2030. Gas prices follow oil prices, while coal prices remain overall lower, although relative coal prices are revised upwards. Energy prices are based on the stochastic PROMETHEUS world energy market model and are comparable to the energy price figures in the IEA World Energy Outlook 2009[8]. These higher price assumptions have non-negligible consequences on the subsequent energy projections, as well as on the height of the carbon value required to meet the GHG emission reduction targets.

Table 2: Comparison of macro assumptions of 2007 and 2009 *baselines* for Belgium

		2007 baseline		2009 baseline	
		2020	2030	2020	2030
GDP annual growth rate	2005//2020 (resp. 2030)	2.1	1.9	1.7	1.7
GDP	Billion €'05	409.2	477.7	389.5	458.5
Population	Million	10.8	11.0	11.3	11.7
Oil price	$08/boe	64.6	66.4	88.4	105.9
Gas price	$08/boe	48.6	50.3	62.1	76.6
Coal price	$08/boe	15.5	15.7	25.8	29.3

Source: NTUA, EC/DG ENER.
Boe: barrel of oil equivalent.

Table 3: Macroeconomic and demographic assumptions for Belgium, 2005-2020

	2005	2020	20//05
Population (in millions)	10.446	11.322	0.5%
Number of households (in millions)	4.445	5.123	1.0%
Household size (inhabitants per household)	2.35	2.21	-0.4%
GDP (in 000 millions € of 2005)	302.1	389.5	1.7%
Gross value added (in millions € of 2005)	268862	346245	1.7%
Industry	44200	57646	1.8%
Iron&Steel	2929	2754	-0.4%
Non-ferrous metals	1454	1532	0.3%
Chemicals	9076	11060	1.3%
Non-metallic minerals	2328	2984	1.7%
Pulp & paper	3418	5147	2.8%
Food, drink and tobacco	6178	8602	2.2%
Engineering	12472	17481	2.3%
Textiles	1932	1744	-0.7%
Other (incl. printing)	4412	6341	2.4%
Construction	12988	16602	1.6%
Tertiary	204227	264175	1.7%
Market services	103264	132563	1.7%
Non market	63659	82308	1.7%
Trade	35062	46770	1.9%
Agriculture	2242	2535	0.8%
Energy sector	7447	7822	0.3%

Source: EC-DG ENER (2010).
//: average annual growth rate.

[8] The IEA World Energy Outlook 2010 shows, however, higher price figures. For instance, oil prices are 23% (resp. 12%) higher in 2020 in the current (resp. new) policy scenario presented in this publication.

2.2.2. Policy context

Further, the *baseline* assumes policies and measures implemented up until spring 2009. All policies and measures that have been implemented up to that date and also those of which the legislative provisions are defined in such a way that there is little uncertainty on how they should be implemented in the future are included in the *baseline*. The 2009 *baseline* incorporates therefore the effects of regulatory energy efficiency measures defined at EU level that have already been implemented, e.g. the five Eco-design implementing measures adopted until April 2009 (see EC/DG TREN, 2010). The recast of the Energy Performance of Buildings Directive is not included in the assumptions, but implemented national measures on e.g. building codes are reflected. The cut-off date of April 2009 allows for capturing the important eco-design regulations that have come into force in early 2009 and will have a long lasting effect. Such regulations concern, for example, the progressive banning of inefficient light bulbs from September 2009 onwards.

The *baseline* takes account of the *CO_2 from cars* regulations requiring strong reductions in the average fuel consumption of new cars. This is done because a regulation is directly applicable in all Member States and does not need to be transposed into national law. Transposition is needed for Directives. Therefore, the new RES Directive with legally binding national targets on the RES share in gross final energy consumption is not part of the *baseline* whereas the existing policy measures on renewables up to spring 2009 are incorporated. For other Directives, such as the Directive on end-use energy efficiency and energy services, the Directive on fuel quality, the Large Combustion Plant Directive etc, a similar approach is followed.

As to the *ETS* prices, they are determined so that the cumulative cap set for GHG covered by the ETS is respected, assuming a maximum permissible use of international credits[9]. While international credits tend to decrease the ETS price, banking would increase it. In this approach, a great deal of banking is accepted, which can become interesting when prices are low and expected to rise in the future. Under these assumptions, i.e. the economic crisis and the policies implemented up to spring 2009, rather low carbon values result in the ETS (see Table 1).

Regarding the *non-ETS* sectors, the modelling does not impose the achievement of the agreed targets for 2020 because, similar to the targets in the renewables Directive, the achievement depends on the forthcoming policies and measures in the individual Member States.

For a full inventory of legal measures and policies taken up in the *baseline*, the reader is kindly referred to consult *EU energy trends to 2030-update 2009*, p. 17-19.

As to *nuclear energy*, a shift in policy can be noticed compared to the 2007 *baseline*. In October 2009, further to the publication of the GEMIX report on the ideal energy mix for Belgium towards 2020 and 2030, the federal government announced its decision to reconsider the 2003 Act concerning the gradual phase out of Belgian nuclear energy and to postpone the retirement of the three oldest nuclear power plants Doel 1, Doel 2 and Tihange 1 to 2025. These three power plants, instead of being closed after 40 years of service, would then see their operational lifetime extended with another 10 years. The entire

[9] Further information on how the ETS carbon price is modelled in PRIMES is provided in (EC/DG Energy, 2010).

nuclear power production park (about 6 000 MW) will close its doors between 2022 and 2025 as foreseen by the 2003 Act, the last nuclear kWh being generated in 2025.

This study, which rests on model simulations carried out during the first half of 2010, accounts for the above context[10]. This context was also included in the recent studies and analyses published by the European Commission (e.g. EU energy trends to 2030, COM(2010) 265 final, COM(2011) 111 final). However, it is worth noting that, since the quantitative assessment of the different scenarios was finalised, two events took place that question the assumption used for nuclear energy: firstly, the fall of the Belgian federal government in spring 2010 before the governmental decision has been translated into law, and secondly, the tragic nuclear accident in Japan earlier this year.

Notwithstanding this likely drawback in the scenario analysis presented in this report, overall the assumption on nuclear energy in Belgium up to 2020 should not affect much the results: the power sector belongs to the EU-ETS and the ETS carbon price is determined at EU level. (Gusbin et al., 2007) showed that the assumption on nuclear in Belgium only has a negligible impact on the ETS carbon price and that the development of RES in the power sector is essentially driven by the RES target.

Carbon Capture and Storage has been included in the *baseline* considering specific support for this technology e.g. through EU means, which include the money earmarked in the European Economic Recovery Plan for CCS as well as funds from the NER 300[11]. The ETS price and the expectations about future emission caps can also trigger CCS investment. CCS demonstration plants contribute to accelerate technology learning in CCS, which further facilitates CCS investment in the time period close to 2030. Development of CCS is hence endogenous in the model (except for the pilot plants commissioned before 2020), depending on carbon prices (ETS), relative fuel prices and CCS technology dynamics. Cost of storage and transportation follows a non linear cost supply curve.

2.2.3. Some general assumptions

- Tax rates are kept constant in real terms.
- On discount rates/capital costs, the current financial crisis is taken into account and therefore the implicit risk premium is higher for the medium term reflecting greater prudence of banks to give credits. This is relevant in particular for innovative technologies.
- Degree days, which capture the effects of possible variations in weather conditions having a noticeable impact on energy consumption, have been kept constant at the 2005 level. This ensures direct comparability of projections with Eurostat data for 2005 and implies furthermore that the *baseline* does not consider the effects of future climate change, where the speed and geographical distribution of e.g. warming or precipitation patterns is still uncertain (and not directly subject of energy analysis).

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10 The recommendation put forward in the Prospective Study on Electricity (FPS Economy & FPB, 2009), being that the nuclear phase out does not happen overnight, has also been included. Therefore, the year before the phase out, only half of the production capacity is in operation. Replacement capacity then has to be available (up and running) already in the year before the final cut off date (2024).

11 The New Entrant Reserve (NER) 300 Scheme is a European Union led funding programme to support CCS and innovative renewables projects. The NER makes funding available for commercial-scale CCS projects, with the funds generated through the sale of 300 million EU ETS allowances from the New Entrant Reserve of Phase III of the EU Emissions Trading System (EU ETS). The European Commission estimates that the sale of these allowances will rise between 4.5 billion € and 9 billion €, dependent on the carbon price.

3. The baseline

Before going into the specificities of the GHG and RES target scenarios, a concise analysis of the *baseline* is provided. The *baseline* and its underlying assumptions are of utmost importance for the purpose of this study as they form the basis for subsequent benchmarking of the target scenarios.

The *baseline* simulates current trends and policies as implemented in Belgium by spring 2009 (see also 2.2.2). While informative about the development of policy relevant indicators such as the renewables share in 2010, the *baseline* does not assume that targets will necessarily be met. The numerical values for these indicators are outcomes of the model; they reflect implemented policies rather than targets. This also applies for CO_2 and GHG emissions (e.g. the GHG emission reduction target in the non-ETS sectors in 2020). The *baseline* thus describes what the Belgian energy future could look like if no additional actions are taken. It is therefore not a forecast of what we think is going to happen or should happen, it merely takes stock of where we might go if nothing changes from current trends and policies.

In what follows, the *baseline* will be described for a selection of key energy and emission indicators. This *baseline* differs in a few respects from the *baseline* for Belgium as made available by DG ENER in February 2010 and published in *EU energy trends to 2030-update 2009* on September 14, 2010. The differences relate to an update in statistics and short term projections for renewable energy sources, an adaptation of nuclear capacity following a recommendation from the Belgian Prospective Study on Electricity (for more details, see 2.2.2) and a revision of the development of natural gas heating, which seems to be more in line with the actual connection policy and measures applied in the Flemish part of Belgium as well as observed in the projections described in the Belgian Prospective Study on Natural Gas (forthcoming).

3.1. Energy trends

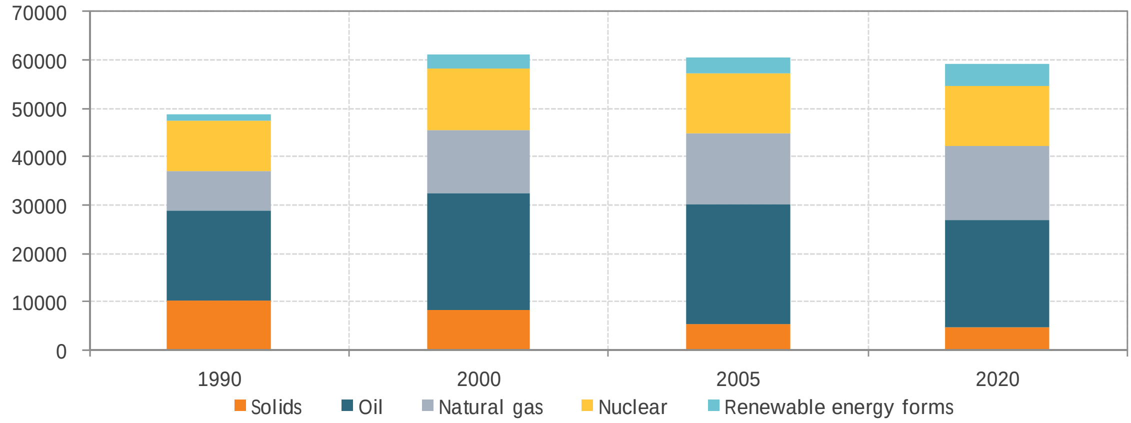
3.1.1. Gross Inland Consumption

The first indicator scrutinized is the Gross Inland Consumption (GIC) or Primary Energy Demand. The GIC is an indicator that describes a nation's total energy consumption and that consists of primary production (energy sources that are exploited on the nation's soil, e.g. wind and hydro) and net import (energy sources that are imported by the country, e.g. oil). The figure below shows that the Belgian GIC, after a period of steep increase between 1990 and 2000, follows a decreasing trend[12]. In 1990, GIC reached 49 Mtoe; in 2000, it was up to 61 Mtoe. In 2020, GIC is projected to amount to 59 Mtoe.

Throughout the period, solids loose much of their relative weight (from a share of 21% in 1990, they tumble down to 8% in 2020). Oil and nuclear energy manage to keep their shares relatively stable throughout the period (the share of oil in the GIC dangles between 36% and 40%, while nuclear energy represents around one fifth of Belgian inland energy provision). Meanwhile, the share of natural gas expands considerably from 17% in 1990 to 26% in 2020, together, but to a far lesser extent, with renewable energy sources which, in 2020, represent 8% of GIC, up from a mere 3% in 1990.

12 More precisely, (provisional) figures for the years 2008, 2009 and 2010 indicate that the Belgian GIC follows a U-shaped curve reflecting the 2008 recession followed by a subsequent recovery.

Figure 1: Gross Inland Consumption by fuel, baseline, evolution
ktoe

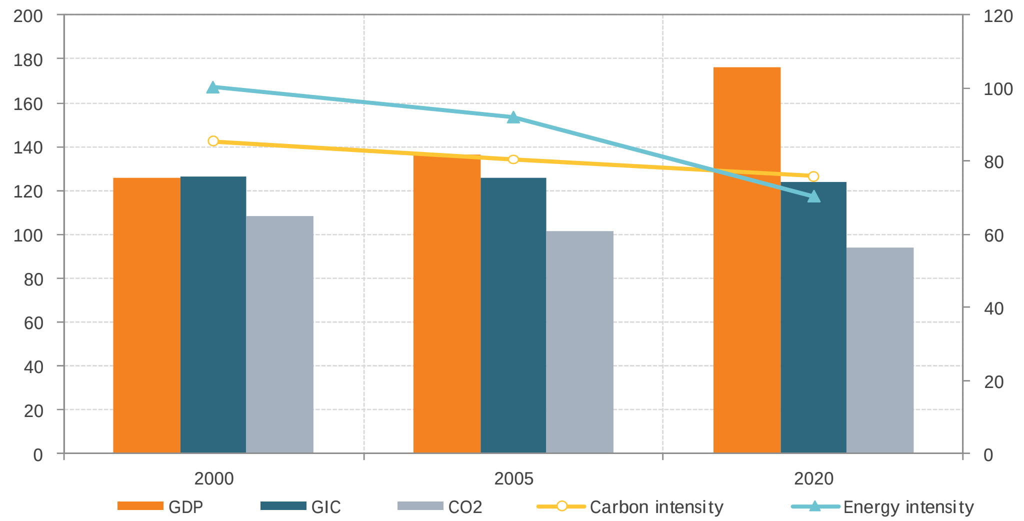


Source: Eurostat, PRIMES.

Next, the GIC (or Primary Energy Demand) is shown in relation to some other parameters. We see that, since the Belgian GDP grows, the energy intensity (i.e. the ratio between GIC and GDP) decreases. In other words, the consumption of energy does no longer go hand in hand with the growth in economic activity. This is due to two factors: on the one hand, the installation of the ETS system has caused concepts of energy efficiency to further penetrate in industrial and other processes, on the other hand, the *baseline* includes important new legislation aiming at higher efficiency, notably for energy in buildings as well as for cars, lighting and electric appliances. Although energy intensity decreases, it is worthwhile mentioning that Belgium is (and stays) an energy intensive country. The share of energy costs as percentage of GDP ranks amongst the highest in the EU15[13], caused by the relatively energy intensive national industry and the apparently elevated energy consumption of Belgian households and tertiary sector.

After a growing trend in the decade 1990-2000, energy related CO_2 emissions fall between 2000 and 2020. Belgium seems to have set pace for a less carbon intensive energy system. Carbon intensity (i.e. the ratio between energy related CO_2 emissions and GIC) goes down. This is in large part due to the decrease in coal consumption and to the development of renewable energy sources.

Figure 2: GDP, GIC, CO_2, energy and carbon intensity, baseline, evolution
Index 1990-100



Source: Eurostat, PRIMES, EC-DG ENER (2010).
The 3 first indicators are depicted in relation to the left axis, the 2 others relate to the axis on the right.

[13] See *EU energy trends to 2030-update 2009*.

3.1.2. Final Energy Demand

Zooming in on the Final Energy Demand (FED, i.e. the energy consumption of industry, house-holds, the tertiary sector (including agriculture) and transport), we see that between 2005 and 2020, the FED increases only by 2.3% (or an average annual growth rate of 0.1%). This modest growth rate is mainly due to the economic crisis and hides in fact two opposite movements: on the one hand, the decrease in final use of solids and oil, on the other hand, the increase in electricity demand, natural gas and the "other" category. The plunge in solids is mainly due to its diminished use in the iron and steel sector[14]. The oil dip can be attributed to a decrease in oil demand for transport (owing to an improved private cars' efficiency and the growing use of biofuels in private car transport, both triggered by the CO_2 on cars regulation, as well as a less pronounced growth of transport activity as a result of lower GDP growth triggered by the crisis), next to a declining consumption for residential heating purposes. Natural gas has already largely found its way in final demand and is mainly used for cooking and heating, natural gas heating being encouraged by a number of specific policies as it is the least CO_2 emitting fossil fuel. Electricity in Final Energy Demand expands due to a number of specific applications such as heat pumps. This ongoing electrification seems to be in line with the Directive on end-use energy efficiency and energy services. The "other" energy forms, being renewable energy sources like biomass and solar thermal, develop the most, but represent a rather minor share in total FED.

In terms of final demand sectors, industry occupies the largest share in both years, followed by the residential sector and transport. Demand in the tertiary sector increases significantly over the projection period, but in the year 2020, it only represents 14% of the total Final Energy Demand.

Table 4: Final energy demand by energy form and sector, baseline, year 2005 and 2020

	2005		2020		Difference 2005-2020	
	ktoe	share	ktoe	share	ktoe	%
Solids	2080	5%	1750	4%	-331	-16%
Oil	16529	43%	15254	39%	-1275	-8%
Natural gas	10009	26%	10556	27%	547	5%
Electricity	6894	18%	7821	20%	927	13%
Other	2930	8%	3931	10%	1000	34%
Industry	13563	35%	13706	35%	143	1%
Residential	9938	26%	10249	26%	310	3%
Tertiary	5017	13%	5501	14%	484	10%
Transport	9926	26%	9856	25%	-70	-1%
Total	38443		39312		868	2%

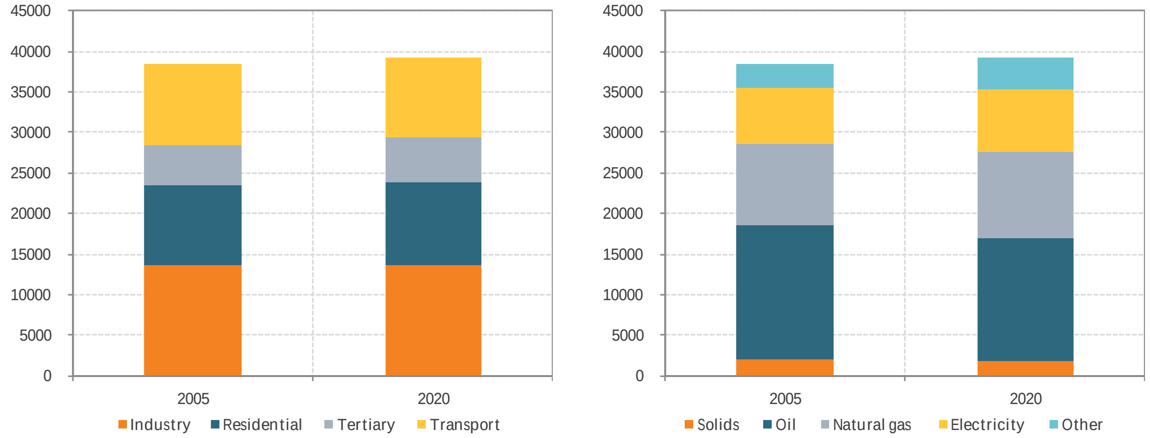
Source: Eurostat, PRIMES, own calculations.

The two figures below visualize the information given in Table 4 above: they depict the evolution of the FED between 2005 and 2020, subdivided according to sector or energy form.

[14] This is caused by both a reduced activity of the sector and a partial switch within the sector to electric processing.

Figure 3: Final Energy Demand, baseline, year 2005 and 2020

ktoe



Source: Eurostat, PRIMES.

3.1.3. Power generation

Turning to the power generation sector, a first indicator of interest is the evolution of the electricity demand. In 2005, called-up electrical power[15] ("énergie appelée") reached 88 TWh, in 2020 under *baseline* assumptions, 99 TWh will be consumed. This boils down to an average annual growth of 0.8%, way lower than the 1.6% observed in the WP 21-08 baseline. This lower average annual growth rate can be subscribed to the economic crisis and the new efficiency policies included in the *baseline* inducing a significant slowdown of demand for electricity. Nevertheless, the phenomenon of electrification in final energy demand persists (see also Table 4).

To satisfy demand, production has to follow[16]. The breakdown of the net electricity generation is depicted in the figure below. A switch in shares can be noticed between gas and renewable energy sources (RES), pointing to the fact that the increase in electricity production originating from renewable energy sources takes place mainly to the detriment of natural gas. Solid fuels, oil and nuclear manage to keep their shares (quasi) intact.

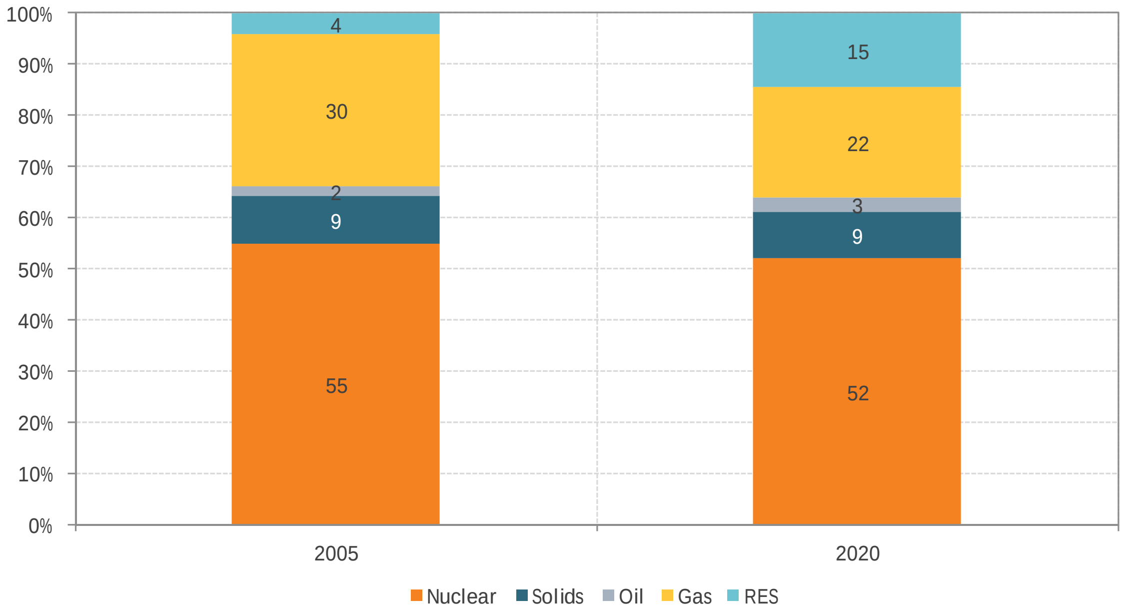
The above evolution (level and structure) translates into an increase in the average cost of power generation by 31% between 2005 and 2020. Furthermore, total investment expenditure in power generation between 2006 and 2020 is estimated at about 9 billion € (in € of 2005). Investment expenditure encompasses the replacement of existing plants that are decommissioned and additional production capacities required by the increase in electricity demand.

15 This is the net electricity consumption plus the grid losses.

16 Electricity demand can also partially be met through (net) imports. These are however set exogenously and do not change according to the scenario: they amount to 11.6 TWh in 2020, compared to 6.3 TWh in 2005. The exogenous levels of electricity imports are based on the best knowledge of Member State policy and national Transmission System Operator's plans.

Figure 4: Net electricity generation, baseline, year 2005 and 2020

%



Source: Eurostat, PRIMES.

Zooming in on power generation based on renewable energy sources, the table below summarizes net power generation and installed capacity for the 4 sources of renewables (hydro, wind, biomass & waste and solar PV). With the currently implemented or approved policies (green certificates, investment subsidies, etc.), the net installed RES power capacity grows from a rather low 840 MW in 2005 to approximately 4 700 MW installed in 2020[17]; subsequent electricity generation based on RES grows from 3 400 GWh in 2005 to almost 13 000 GWh in 2020. This means that the share of RES in total electricity production increases from a 4% share in 2005 to 15% in 2020. The power capacity grows faster than the production due to the intermittent nature of (some of) the renewables. In 2020, the largest capacity will be provided by wind energy, with total wind capacity estimated to be 2 884 MW, of which 1 404 MW onshore and 1 480 MW offshore.

Table 5: RES net power capacity and net electricity generation, baseline, year 2005 and 2020

	Net power capacity (MW)		Net electricity generation (GWh)	
	2005	2020	2005	2020
Hydro	116	138	284	404
Wind	167	2884	226	7939
Biomass and waste	556	1361	2853	4125
Solar PV	2	297	1	286
Total	841	4680	3363	12755

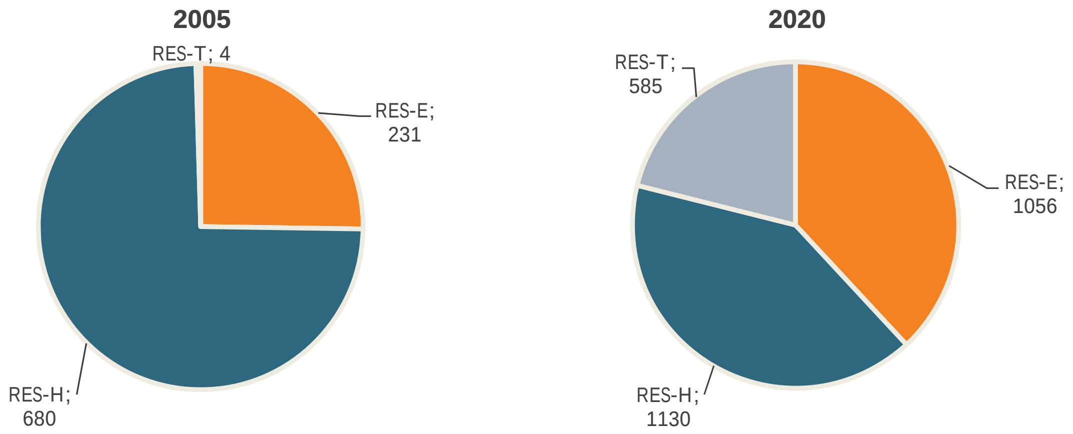
Source: Eurostat, PRIMES.

17 Notice that RES installed power capacity in the baseline 2009 is about 18% higher than in the WP 21-08 equivalent, despite the presence of the entire nuclear power park in 2020. Main reason is the incentive given by higher overall international energy prices and a superior ETS carbon value in the 2009 exercise.

3.1.4. RES in Gross Final Energy Demand

The European Directive 2009/28/EC on renewable energy sources subscribes to a 20% share of renewable energy in Gross Final Energy Demand by 2020 for the EU as a whole (including a 10% share of renewable energy in transport for each Member State). For Belgium, this boils down to a national target of 13%. In the *baseline*, nonetheless, without the adoption or implementation of any additional incentives or actions after spring 2009, we see that we are still a long way from reaching this objective. Starting from an absolute amount of 910 ktoe (10 600 GWh) of RES in 2005, we arrive at 2 752 ktoe (32 000 GWh) by the year 2020. Expressed in percentage of Gross Final Energy Demand, this amounts to 2.3% in 2005 and 6.9% in 2020. The figure below shows the split of RES in Gross Final Energy Demand according to its final use (heating and cooling[18], electricity and transport or RES-H, RES-E and RES-T).

Figure 5: RES in Gross Final Energy Demand, baseline, year 2005 and 2020
ktoe



Source: Eurostat, PRIMES.

The expansion in the share of biofuels is remarkable: it rises from a negligible 4 ktoe in 2005 to a vast 585 ktoe by 2020. However this sharp rise is not sufficient to meet either the 2010 indicative target of 5.75% or the 2020 target of 10%, as the share of biofuels only reaches 3.6% in 2010 and 7% in 2020.

18 As it does not seem trivial to estimate the amount of renewable energy consumed by heat pumps (due to an apparent absence of threshold, the lack of data on the existing stock of heat pumps and their average coefficient of performance), the contribution of heat pumps to RES-H is not taken into account. This causes a (slight) underestimation of (the percentage of) RES-H.

3.2. Emission trends

According to PRIMES calculations based on Eurostat energy balances, Belgium emitted 117.5 Mt of CO_2 in 2005. This figure includes CO_2 emissions from international aviation and non-energy related CO_2 emissions. As far as non-CO_2 GHG emissions are concerned, GAINS reports 18.3 Mt of CO_2-equivalent in 2005. Summing up these two figures leads to 135.8 Mt of CO_2-equivalent for the GHG emissions in Belgium in 2005. This data deviates from that reported in the last GHG emission inventory of 2010[19] (i.e. 141.5 Mt) by 4%. This discrepancy results, on the one hand, from differences in energy statistics, and on the other, from changes in the reported data for the year 2005. The former diverging factor has been well known for several years. At this stage, however, we are unable to solve this problem. We chose to work with the PRIMES data and acknowledge that there is a difference with the officially reported emission data.

Table 6: GHG emissions in Belgium, baseline

	1990 (Mt CO_2 eq.)	2005 (Mt CO_2 eq.)	2020 (Mt CO_2 eq.)	2020 vs. 2005 (%)
All GHGs	139.9	135.8	128.4	-5.4
All CO_2	115.5	117.5	111.3	-5.3
ETS sectors		58.4	52.5	-10.1
ETS without aviation		54.6	48.0	-12.1
Aviation		3.8	4.5	18.6
Non-ETS sectors		77.4	75.9	-1.9
Energy related CO_2		59.1	58.9	-0.5
Non-CO_2 GHGs		18.3	17.1	-6.4

Source: PRIMES, GAINS, NTUA.

NB: The allocation of total GHG emissions between ETS and non-ETS is made according to scope '08-12'. The model based emission data differ from the emissions officially reported to the UNFCCC. However, the former are coherent with the model results to 2020 which therefore allow getting insight into the energy-climate policy of Belgium.

Table 6 also shows that the ETS sector accounts for 43% of the total GHG emissions in 2005.

Under *baseline* assumptions, total GHG emissions in Belgium are projected to decrease by 5.4% in 2020 compared to 2005. This evolution reflects a double movement, being a small decrease in the non-ETS sector (-2%) combined with a more significant decrease in the ETS sector (-10%). The small decrease in the non-ETS sector is in fact the sum of a status quo in energy related CO_2 and a decrease in non-CO_2 GHG emissions. The evolution in the ETS sector mainly results from the dip in economic activity due to the financial-economic crisis and the subsequent slow recovery, combined with a non-negligible carbon price, a rise in international energy prices and the prolonged presence of the entire nuclear power park up until 2025. By 2020 only 41% of the total GHG emissions are expected to come from the ETS sector.

19 EEA, *Annual European Union greenhouse gas inventory 1990- 2008 and inventory report 2010.*

4. The 20/20 target scenario

The *20/20 target* scenario mimics the implementation of the Climate-Energy legislative Package and is based on the Reference scenario presented in *EU energy trends to 2030 – update 2009*, European Commission, DG ENER and in the Communication of the European Commission of June 2010 (COM(2010) 265/3).

While evaluating this scenario it is worth underlining that:
– It was constructed with a double target in mind for the year 2020: a greenhouse gas emission reduction objective coupled to a renewable development target. As both targets were taken up in the modelling, it is not possible to isolate the impact one single objective can have on the energy or economic system;
– It sticks to the current Climate-Energy legislative Package for the year 2020. It does not include any additional policies or targets for non-ETS sectors and RES beyond 2020[20].

4.1. Description/rationale

The *20/20 target* scenario is a reduction scenario in which the 20% reduction in greenhouse gases by 2020 compared to 1990 levels is attained at European level and the 20% share of renewable energy in Gross Final Energy Demand by 2020 for the EU as a whole is reached, including a 10% share of renewable energy in transport in each Member State.

At the Belgian level, the non-ETS, ETS and RES objectives are as follows:
– Firstly, in the non-ETS sector, the implementation of the burden sharing for non-ETS GHG reduction as stated in the Decision No. 406/2009/EC on effort sharing is integrated. This boils down to a Belgian non-ETS GHG reduction target of 15% in 2020 compared to 2005 emissions.
– Secondly, the effort performed in the Belgian ETS sector depends on the cap that is determined at EU level. The general allocation rule for the EU allowances to companies is auctioning. Nevertheless, companies belonging to sectors facing the risk of carbon leakage will receive free allowances.
– Thirdly, on renewable energy, the scenario includes the Belgian target for the share of energy from renewable sources in the Gross Final Energy Demand by 2020 as specified in the Directive 2009/28/EC (April 23, 2009) on the promotion of the use of energy from renewable sources, namely a 13% share of renewable energy in Gross Final Energy Demand.

The scenario takes into account the various flexibilities allowed for in the European legislative Decision and Directives. However, the 'temporal flexibility' permitted in the Directives (namely 'carry-back' and 'carry-forward' in the non-ETS and banking in the ETS) cannot be analysed with the model used in this study.

As far as the RES target is concerned, Directive 2009/28/EC foresees the possibility in its article 36 for any Member State to reach part of its objective in another Member State through statistical transfers, joint projects between Member States or joint support schemes. In a Forecast document handed in six

[20] Consequently, EU GHG emissions in 2030 are 24% below the level of 1990. In the ETS, the carbon value increases slightly to reach 18.7 €/t CO_2 in 2030. In the non-ETS, the carbon value stays constant at 5.3 €/t CO_2 over 2020-2030.

months before the official deadline of the National Renewable Energy Action Plan (June 30, 2010), Member States had to provide an estimation of their potential excess production or deficit of renewable sources in addition to domestic sources. Belgium in this regard stated that it "does not exclude the possibility of using the cooperation mechanisms" to meet its objective. Most of the Member States nevertheless expressed the opinion in their respective Forecast Documents that they expected to follow indicative trajectories that set midterm goals up to 2020. This means that they do not expect to need help to meet their own targets, nor to contribute towards others' goal, hence limiting the flexibility option for RES and thereby explaining the PRIMES modelling choice to reach domestic targets internally or with very limited use of flexibility, only for those Member States that have indicated that they plan or may need[21] to draw on the so called co-operation mechanisms.

Non-ETS legislations give considerable freedom to Member States on how they can achieve their target, allowing for transfers between Member States if some exceed their national targets. For the achievement of the non-ETS target, it is assumed that this flexibility is used. Consequently, a uniform non-ETS carbon value across the EU is assumed, meaning that marginal abatement costs in the non-ETS sector will be equalized across EU countries. Each year, marginal abatement costs will thus be equal to the carbon value.

In the ETS sector, all EU companies will make use of flexibility (EU allowances and CDM credits) and equal their marginal abatement cost to the permits' price that is represented by the ETS carbon value.

In the longer term, it is assumed that the stringency of the non-ETS policy remains stable after 2020 and comparable considerations apply for renewable energy policies. The *20/20 target* scenario includes however some more EU legislation (with respect to the baseline) adopted between spring and end of 2009 to reflect further eco-design implementation standards and the recast of the Directive on Energy Performance of Buildings.

The corresponding carbon and renewable[22] values in the *20/20 target* scenario are given in Table 7 and compared to their level in the *baseline*. Given the above, same carbon values for ETS and non-ETS are valid in the EU27 whilst the renewable value for the European Union is 49.5 €/MWh.

Table 7: Carbon and renewable values for Belgium, baseline and 20/20 target scenario, year 2020

	Baseline	20/20 target scenario
Carbon value - ETS (€/tCO_2)	25.0	16.5
Carbon value - non-ETS (€/tCO_2)	0.0	5.3
Renewable value (€/MWh)	0.0	82.0

Source: NTUA.

21 This is the case of Belgium: *In order to achieve its objective by 2020 [...] Belgium may consider resorting to the cooperation mechanisms for maximum 0.5% of the expected final consumption [...].* (Forecast document for Belgium, December 2009).

22 National RES values are determined in such a way that national Forecast Documents, complying with Article 4(3) of Directive 2009/28/EC on the promotion of the use of energy from renewable energy sources, are taken into account. For Belgium, this means that the RES value is the result of a 12.5% RES in GFEC deduction, following the statement in its Document handed in January 2010:
"Belgium does not exclude the possibility to use the cooperation mechanisms... Belgium may consider resorting to the cooperation mechanisms for maximum 0.5% of the expected final consumption".

As can be seen in Table 7, the ETS carbon value in the *20/20 target* scenario is lower than the value used in the *baseline*. The ETS emissions' profile changes considerably, given that the renewable energy target induces actors to reduce emissions significantly by 2020 even when ETS carbon prices are actually lower than *baseline*'s. Instead of a carbon price of €25 by 2020 (as in the *baseline*), the carbon price decreases to €16.5 in 2020.

On top of that, the non-ETS carbon value is rather small, way smaller than the ETS CV (16.5 €/tCO_2) and the non-ETS CV applied in the WP 21-08 (25 €/tCO_2). This comes from the fact that the achievement of the renewables targets will go a longer way towards reaching the GHG reduction targets in the non-ETS than originally modelled, combined with higher international fuel prices, hence much less additional carbon price incentives are necessary to reduce GHG emissions. The lower economic growth forecast makes achievement of the GHG reduction targets easier whereas it does help less for the achievement of the renewables target, and the latter therefore dominates the efforts needed for target fulfillment. Achieving the renewable energy targets reduces emissions in the non-ETS considerably. Only a moderate effort in addition to the achievement of renewable targets would be needed to achieve the GHG reduction targets in the non-ETS. Actually at an additional carbon price of 5.3 €/tCO_2 the non-ETS target would be achieved at the EU level.

The result of a significantly lower non-ETS than ETS carbon value might seem counter intuitive, given that the distribution of efforts between ETS and non-ETS in the Package was mainly decided based on cost-efficiency considerations. Main contributors to alleviate the carbon price burden more significantly for non-ETS than for ETS sectors are higher oil prices and their impact on household and industry fuel demand and the energy efficiency measures which significantly affect non-ETS sectors, in particular the recast Energy Performance of Buildings Directive and the CO_2 and Cars Regulation.

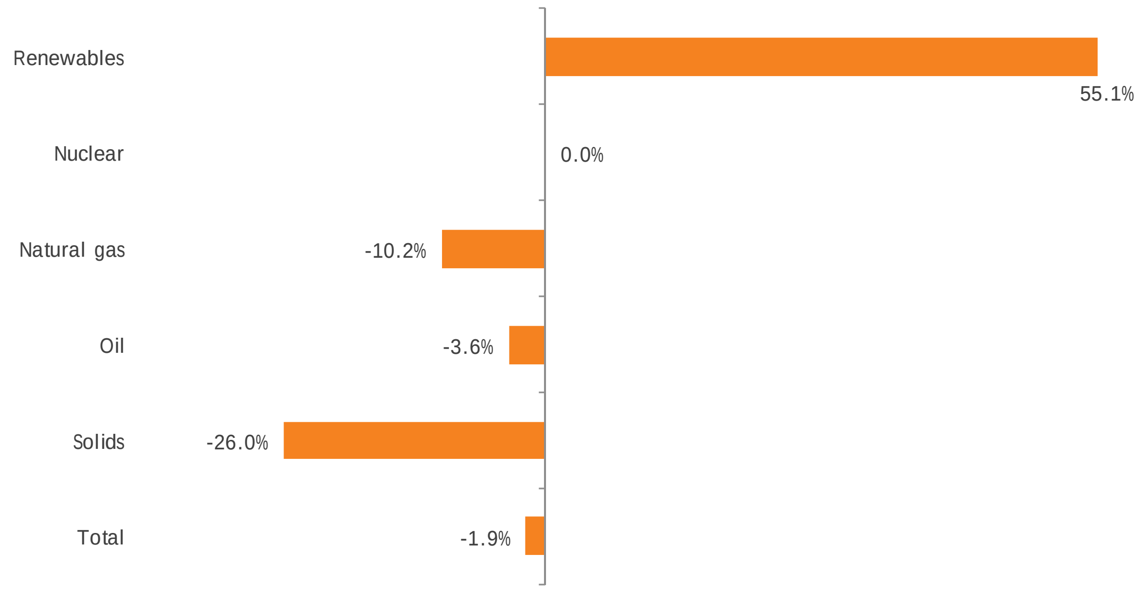
4.2. Impacts on the energy system

Following parameters will for the most part be analysed with respect to the *baseline* and up to the year 2020 (unless stated otherwise). This reasoning is followed to demonstrate the effort society has to make in a given year to reach the set goals for 2020.

4.2.1. Gross Inland Consumption

When implementing the *20/20 target* scenario, the Gross Inland Consumption will be affected in two ways: energy demand will shrink and fuel switching will occur because of the installation of a carbon constraint and a RES target. The following figure demonstrates the impact. In total, the GIC decreases by 2% in comparison to the *baseline*. Hardest hit is the consumption of solids that, through the installation of a joint CV/RV as well as the postponement of the retirement of the three oldest nuclear power plants, becomes a less attractive energy form for the production of electricity and heat. Oil and natural gas will also decline compared to the *baseline*, and even compared to the year 2005 they lose share (they are situated respectively 15 and 5% under the 2005 level). A substantial development of renewables takes place (+55%), but they do depart from a rather small absolute amount (3391 ktoe or 6% of total GIC in 2005).

Figure 6: Gross Inland Consumption, 20/20 target scenario, year 2020
% change compared to the baseline



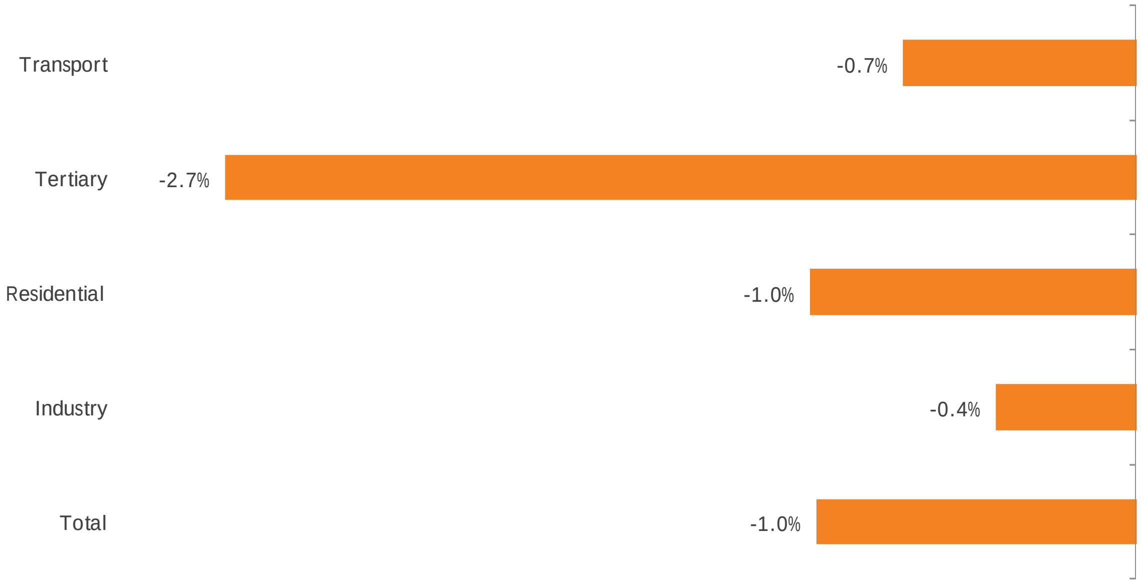
Source: PRIMES.

We see that, when both targets are imposed, both total demand and imports of all fossil fuels, including natural gas, decrease compared to the *baseline*. Interesting to note is that the imposition of the RES target (and matching RV) prevents gas demand from increasing as a substitute for coal in power and steam generation. This finding takes the edge off the possible adverse effects that climate change actions can have on gas import dependence and, hence, on security of supply issues.

4.2.2. Final Energy Demand

When focusing on the final energy demand, we also see a decreasing trend: in 2020, 1% less energy is consumed by the final demand sectors compared to the *baseline*. Tertiary takes the largest cut, followed by households, industry takes the smallest.

Figure 7: Final Energy Demand, 20/20 target scenario, year 2020
% change compared to the baseline



Source: PRIMES.
NB: Transport includes aviation.

The fact that industry is comparatively less affected is caused by a number of reasons. First, the Belgian industry belonging to the ETS is already subject to a carbon value in the *baseline*. Moreover, the *baseline* CV for ETS sectors (a large part of industry being categorised as ETS) is higher than the one applied in the *20/20 target* scenario (25 against 16.5 €/tCO_2 in 2020) while industry belonging to the non-ETS is now subjected to a CV (5.3 €/tCO_2 in 2020). In relative terms, the additional effort on top of the *baseline* effort for industry is thus minor. Secondly, the Belgian industry is already relatively energy efficient (especially the energy intensive sectors). Thirdly, only restricted possibilities for fuel switching exist within industry (due for a large part to certain industrial production processes needing one particular type of energy, e.g. petrochemicals).

For the residential as well as for the tertiary sector, the most important option to reduce CO_2-emissions is the reduction of energy consumption by means of more efficient equipments and lower energy demand as fuel switching options are rather limited. The scarcity of these options are due to a lack of co-generation in non-industrial sectors (e.g. district heating) and the fact that most fossil fuel switching options have already been largely exploited (coal or oil for heating purposes are already largely substituted by natural gas). For households, nonetheless, there appears to be a valid alternative to fossil fuels, being the installation of a heat pump. Heat pumps are able to substitute for fossil fuels in space heating systems by electricity-based technology.

Box 1 Heat pumps

A heat pump is a technology which uses “ambient heat” from the ground, air or water and moves (pumps) this to where it is needed for space heating and/or domestic hot water. Heat (radiation) from the sun is absorbed by the ground, water or air, which is available all year-round. Heat pumps transfer this heat from one medium to another by mechanical means, using some electrical energy to power this process. As solar heat occurs naturally it has no cost or carbon impact. Though capital intensive, heat pumps are economical to run and can be powered by renewable electricity. The most common types of heat pump are air-source heat pumps (ASHP) and ground-source heat pumps (GSHP), depending on whether heat is transferred from the air or from the ground. The efficiency of a heat pump is measured by the coefficient of performance (CoP): for every unit of electricity used to pump the heat, an air source heat pump generates 2.5 to 3 units of heat (i.e. it has a CoP of 2.5 to 3), whereas a GSHP generates 3 to 4 units of heat. Heat pumps can be used in both domestic and non-domestic settings. They can be employed on an individual house basis or as part of district heating.

Both scenarios (*baseline* and *20/20 target* scenario) count on heat pumps for residential heating purposes in the medium term (2020). Penetration rates differ as the *20/20 target* scenario gives more way to efficient heating technologies, integrating the recast Energy Performance of Buildings Directive, further eco-design implementation standards, a renewable target and a, albeit small, carbon value for the non-ETS sectors. The total number of residential heat pumps in Belgium by 2020 is estimated to be around 170 000 in the *baseline*, while the *20/20 target* scenario holds approximately 310 000 heat pumps. Compared with numbers put forward in the Belgian NREAP, the *20/20 target* scenario is a bit more ambitious, whilst the *baseline* still leaves room for progress.

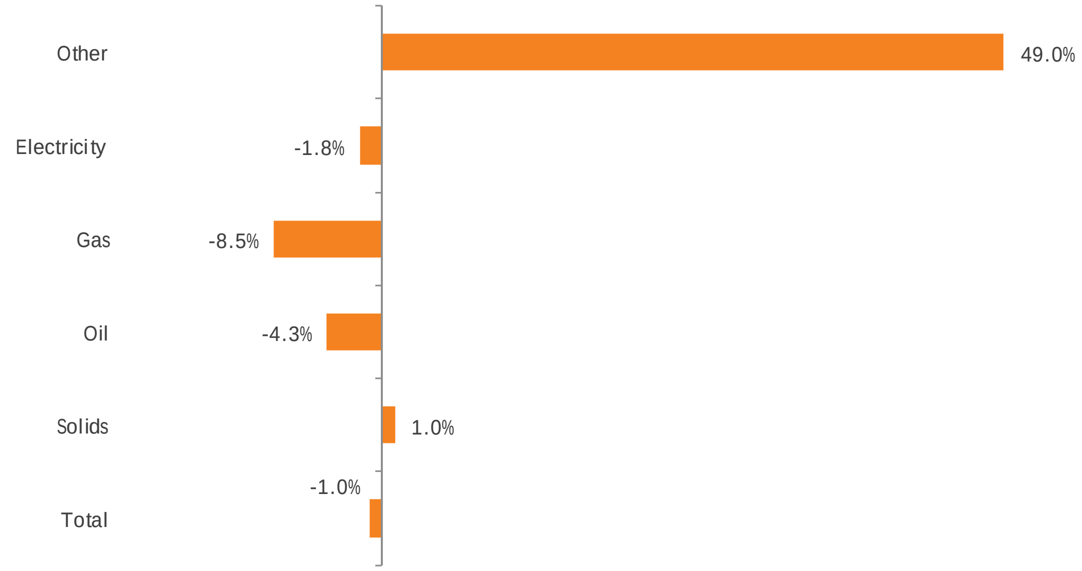
1. National Renewable Energy Action Plan (NREAP), November 2010.

For transport, the small decrease can be attributed to the fact that the *20/20 target* scenario already integrates the CO_2 on cars regulation and that electric vehicles do not experience a massive breakthrough on such a short time span[23].

Looking at the consumption of the different energy forms in Figure 8, the above reasoning is confirmed. Because of more pronounced efforts on the energy efficiency and demand side due to the installation of a twin target and further EU legislation adopted between spring and end 2009, the *20/20 target* scenario economises on its gas, oil and electricity consumption. Solids’ consumption on the other hand does not change much compared to *baseline*, mainly because of the difference between ETS-CVs being small (coal is mainly used in the iron and steel industry). However, compared to 2005, the solids’ consumption in 2020 in the *20/20 target* scenario does plunge by 15%.

23 Incentives given to reach the 10% RES in transport target by 2020 mainly act upon the expansion of biofuels, whereas the large scale development of alternatively propelled motorized vehicles is foreseen from 2030 onwards.

Figure 8: Final Energy Demand, 20/20 target scenario, year 2020
% change compared to the baseline



Source: PRIMES.
NB: "Other" stands for renewable energy and heat.

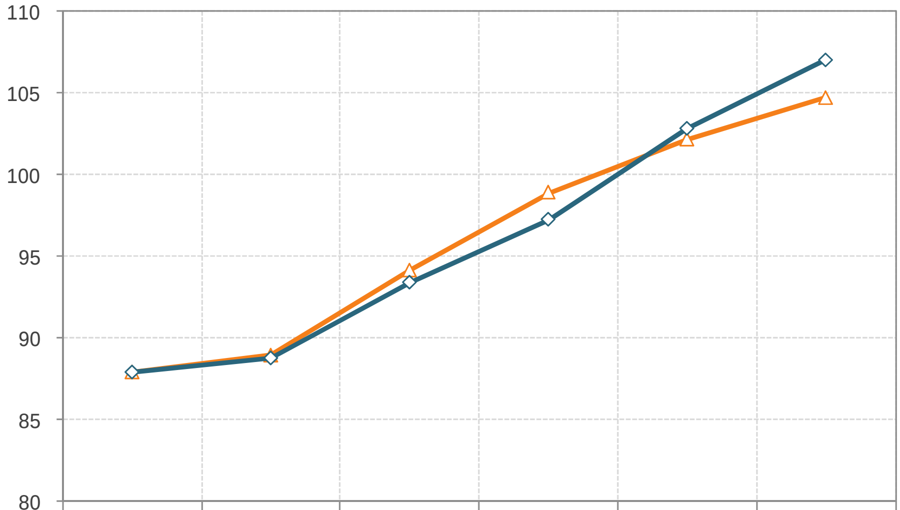
4.2.3. Power generation

Turning to power generation, we see that the GHG and renewables' objectives have an impact on the demand for electricity. When focusing on the period under investigation (2005-2020), one notices that the electricity demand in the reduction scenario is lower than in the *baseline*. This can be attributed to a first reaction of the system to the adoption of a carbon and renewable value, being a decrease in the general demand for energy services, hence electricity. This is mainly due to the fact that time constants in power generation are much longer than in mobile phones for example. Lifespan in power plants reaches 20 to 40 years, meaning that only once every say 30 years, a capital turnover takes place. Therefore the 2020 time horizon is rather short in time for the power sector to develop low cost carbon-free generation at a sufficiently large scale, whereas 2030 is not. When extrapolating over a longer time period (2005-2030), investments in even more efficient and/or carbon-low/carbon-free technologies become within reach. In Figure 9, we notice that, after 2020, the electricity demand recovers and crosses the *baseline* level between 2020 and 2025 to remain at a higher level. In 2030, called-up electrical power[24] reaches 107 TWh (compared to 105 TWh in the *baseline*). This is then due to a second reaction of the system: a fuel switch from more expensive (rise in international energy prices and in CV) fossil energy forms to relatively cheaper ones (e.g. electricity), given time.

[24] This is the net electricity consumption plus grid losses.

Figure 9: Called-up electrical power, baseline and 20/20 target scenario, evolution, 2005-2030

TWh



	2005	2010	2015	2020	2025	2030
Baseline	88	89	94	99	102	105
20/20 target scenario	88	89	93	97	103	107

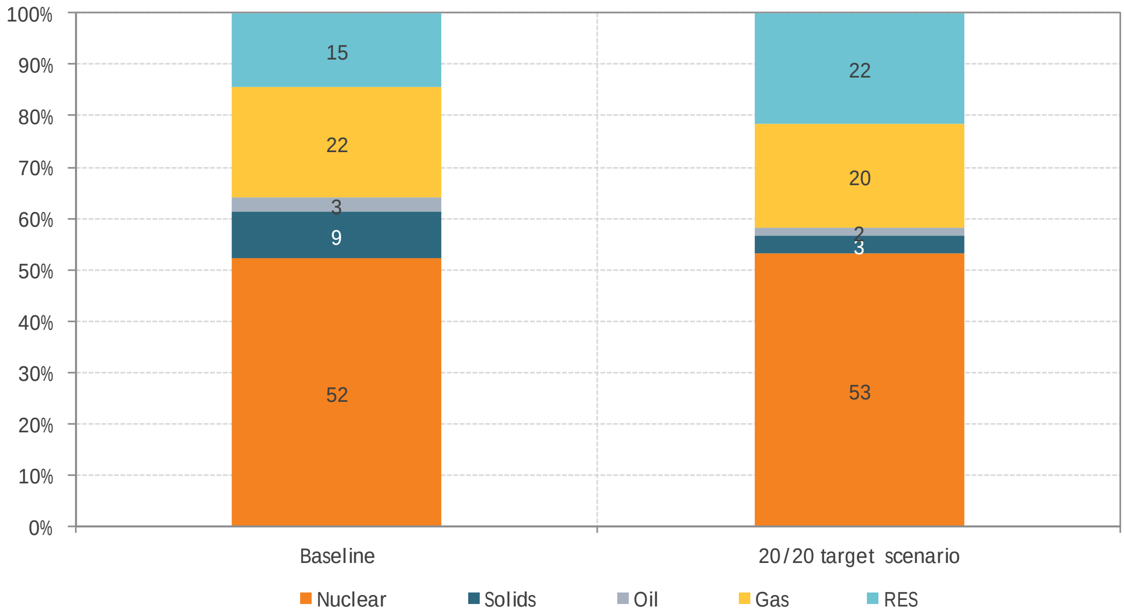
Source: Eurostat, PRIMES, own calculations.

N.B. 2010 figures are projections, not statistics.

To satisfy the demand, power generation must be sufficient. In the *20/20 target* scenario, net electricity generation in the year 2020 will be lower (86 TWh instead of 88 TWh in the *baseline*[25]) and basically consists of nuclear (53%), renewables (22%) and gas (20%[26]). This last finding is represented in Figure 10, together with a comparative decomposition of the *baseline*.

Figure 10: Net electricity generation, baseline and 20/20 target scenario, year 2020

%



Source: PRIMES.

[25] The difference between called-up electrical power and net electricity production can be attributed to net imports and transmission and distribution losses.

[26] Due to the presence in 2020 of the entire nuclear power park which basically provides base load electricity, shares of solids and natural gas are way smaller than in the WP 21-08 exercise.

To summarize the situation in the power sector, Table 8 shows a selection of sector specific parameters for both the *baseline* and the reduction scenario.

Table 8: Indicators related to the power generation sector, baseline and 20/20 target scenario, year 2005 and 2020

	2005	2020 baseline	2020 20/20 target scenario
Efficiency for net thermal electricity production (%)	40.5	39.8	41.2
Net imports ratio (%)	6.9	11.3	11.4
% net electricity from CHP	9.0	15.5	16.3
% electricity from RES	4.1	14.5	21.6
Share of non-fossil fuels in net power generation (%)	59.1	66.7	74.7
Net installed power capacity (GW)	14.7	20.3	20.7
Carbon intensity (tCO_2/GWh)	230	175	111
Electricity (final demand) per capita (kWh/capita)	7675	8033	7889

Source: Eurostat, PRIMES.

The evolution of the average efficiency of thermal electricity production is closely related to the technology mix. Figures are comparable between 2005 and 2020 and between *baseline* and *20/20 target* scenario as the thermal technology mix does not transform radically over time and over scenario.

The level of net imports is exogenously fixed and does not change according to the scenario. It is determined based on the best knowledge of Member State policy and national Transmission System Operator's plans. The net imports ratio (being the ratio between net imports and total electricity supply) increases over time because of higher net imports in both scenarios, basically triggered by a higher intention of the Netherlands to start building capture ready coal plants in the vicinity of harbours with the purpose of exporting electricity.

The share of non-fossil fuels in electricity production combines two elements: nuclear on the one hand, renewable energy sources on the other. As the entire nuclear power park, representing around half of total Belgian electricity provision in 2005, stays available through 2020 further to the assumed delay in decommissioning, the share of nuclear energy stays quasi intact throughout the 2005-2020 period. The share of renewable energy sources then keeps on climbing: representing only 4% in 2005, it reaches 15% in 2020 in the *baseline* and 22% in the *20/20 target* scenario. Similarly, the share of CHP (covering both fossil fuel and biomass based cogeneration) in electricity generation steadily goes up: from 9% in 2005, it reaches 16% in 2020 in both scenarios. This is due to two factors: on the one hand, using biomass in a CHP plant is more efficient than applying biomass in other uses, so the increase in RES causes an increase in biomass based CHP, on the other hand, the further implementation of the Cogeneration Directive 2004/8/EC is part of the policy context simulated in both scenarios.

The installed power capacity increases by 38% over the period 2005-2020 in the *baseline* and slightly more in the reduction scenario (41%). This increase is required to meet the growth in electricity consumption in both scenarios. However, the power capacity increases at a higher pace than electricity demand. Reason has to be searched in the decrease in average utilisation rate of power capacities: in 2005, it was around 64%; in 2020, it is estimated to be 49% in the *baseline* and 48% in the *20/20 target* scenario[27].

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[27] The decrease in average utilisation rate (i.e. generation/(installed capacity x 8 760 hours)) is due to the higher share of power capacities based on intermittent energy sources such as wind and solar.

Next, the subcategory of renewable energy sources in power generation is analysed in more detail. The table below depicts the net power generation and capacity for the reduction scenario in the year 2020, as well as the percentage of change compared to the *baseline* for that same year. Hydro and solar PV (hardly) do not change with respect to the *baseline*, but wind and biomass and waste grow considerably. Both on- and offshore wind contribute to the wind accumulation, leading to an onshore installed capacity of 1 700 MW by 2020, whilst offshore can count on approximately 2 000 MW installed by that year[28]. Wind is also accountable for the largest part (56%) of RES based electricity production (over 10 TWh in 2020).

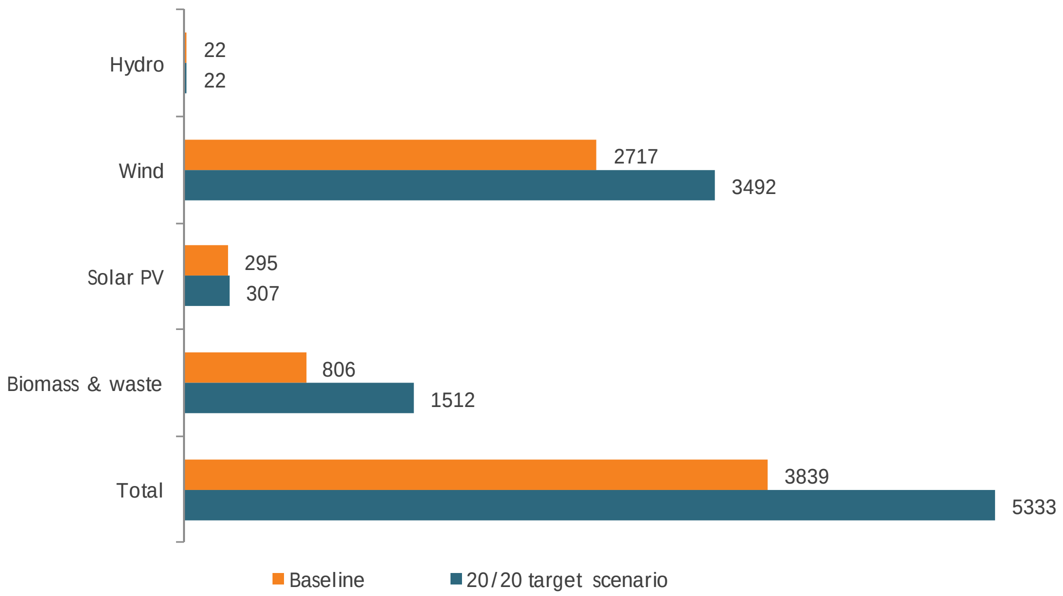
Table 9: RES net power capacity and net electricity generation, 20/20 target scenario, year 2020

	Net power capacity (MW)		Net electricity generation (GWh)	
	2020	% change compared to baseline	2020	% change compared to baseline
Hydro	138	0%	404	0%
Wind	3659	27%	10332	30%
Biomass and waste	2068	52%	7544	83%
Solar PV	309	4%	299	4%
Total	6174	32%	18579	46%

Source: PRIMES, own calculations.

The graph below shows the progression from the year 2005 for the two scenarios discussed until now: the *baseline* and the *20/20 target* scenario. Hydro does not take off spectacularly because of a limited potential in Belgium. Solar PV, on the other hand, does take a head start with spectacular growth rates, but as share in total RES capacity only represents a humble 5% in 2020. Wind and biomass and waste expand considerably in both scenarios, with an expected additional growth of both energy forms in the reduction scenario of approximately 1 500 MW on top of the *baseline*. In total, the reduction scenario banks on an extra 5 300 MW installed starting from the 2005 level (+/-850 MW).

Figure 11: Net installed RES power capacity, baseline and 20/20 target scenario, year 2020: difference from 2005
MW



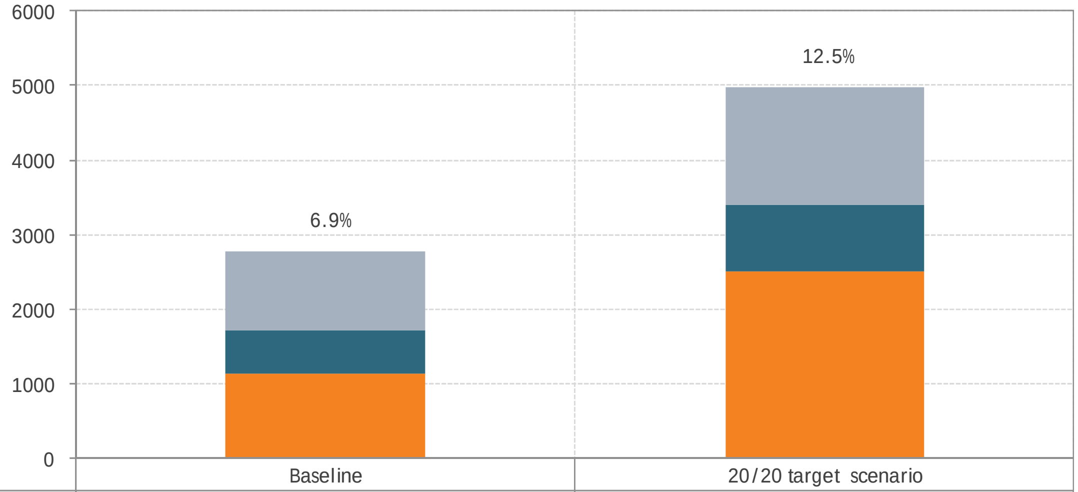
Source: PRIMES.

[28] This is what is foreseen to be potentially built on the North Sea Continental Shelf (Ministerial Council in Oostende, March 21 and 22, 2004, Printemps de l'Environnement, 2008).

4.2.4. RES in Gross Final Energy Demand

After this thorough examination of "electric" renewables (RES-E), we assume a broader view and examine what share RES occupies in Final Energy Demand. As stated in part 3.1.4, a 13% share in Gross FED in Belgium should be reached by 2020 according to the RES Directive 2009/28/EC. In the *baseline*, we saw that a 6.9% share or 2 752 ktoe (32 000 GWh) is obtained with current trends and policies. The *20/20 target* scenario with the aid of a RV steps up this effort and reaches 12.5%. This boils down to an absolute amount of renewables in Gross FED of 4 952 ktoe (57 600 GWh). An extra 0.5% coming from cooperation mechanisms can close the gap with the 13% RES target. Figure 12 then splits up the different uses (heating and cooling[29], transport and electricity, or RES-H, RES-T and RES-E).

Figure 12: Renewables in Gross Final Energy Demand, baseline and 20/20 target scenario, year 2020
ktoe



	Baseline	20/20 target scenario
RES-E	1056	1576
RES-T	585	900
RES-H	1130	2505

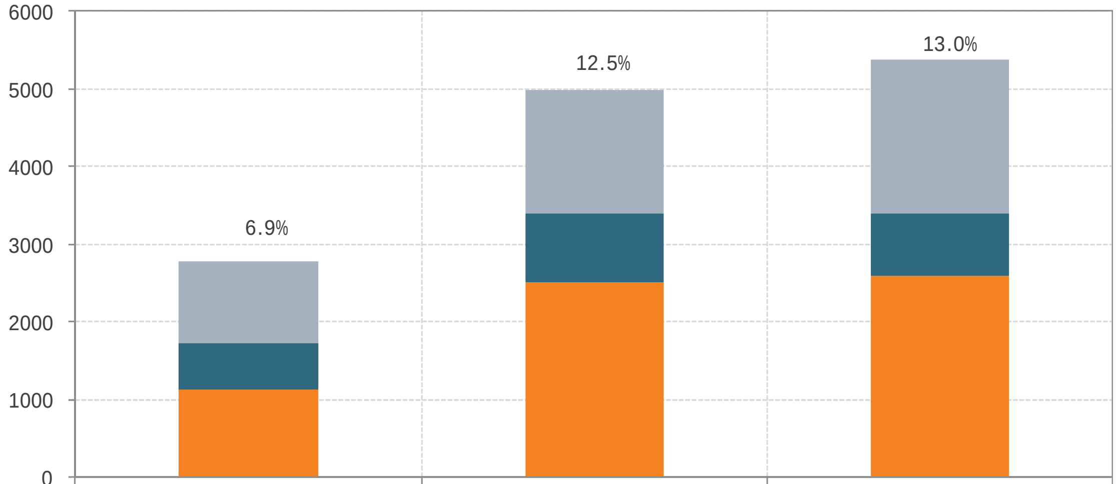
Source: PRIMES
NB: RES-H encompasses at the same time the heat produced in biomass-based CHP as the biomass' and solar heat used for space and water heating.

Since the RES Directive 2009/28/EC includes an objective for renewable energy in transport, the RES-T contribution is looked at in more detail. The final consumption of energy from RES in transport in the target scenario rises to 900 ktoe (i.e. about 11% of transport energy demand), compared to 585 ktoe in the *baseline* (7%) and starting off from a level of 4 ktoe in 2005. In other words, this means that the incentive systems in place to reach the GHG and the RES target (methodologically simulated via the installation of the CV and RV) suffice to reach the set goal of 10% renewable energy in transport for Belgium by 2020.

[29] As it does not seem trivial to estimate the amount of renewable energy consumed by heat pumps (due to an apparent absence of threshold, the lack of data on the existing stock of heat pumps and their average coefficient of performance), the contribution of heat pumps to RES-H is not taken into account. This causes a (slight) underestimation of (the percentage of) RES-H.

Box 2 Fulfilment of the RES target in Belgium: the *20/20 target* scenario vs. the Belgian National Renewable Energy Action Plan (NREAP) in 2020

Compared with numbers put forward in the Belgian NREAP, the *20/20 target* scenario shows slightly different evolutions in 2020 as illustrated in the figure below (ktoe).



	Baseline	20/20 target scenario	NREAP
RES-E	1056	1576	1988
RES-T	585	900	798
RES-H	1130	2505	2588

Total RES consumption in 2020 is projected to be higher in the NREAP than in the *20/20 target* scenario (the difference is about 400 ktoe). Two factors explain the difference: (1) the RES share in gross final energy demand (13% vs. 12.5%) and (2) the projected level of gross final energy demand (41.3 Mtoe vs. 39.8 Mtoe).

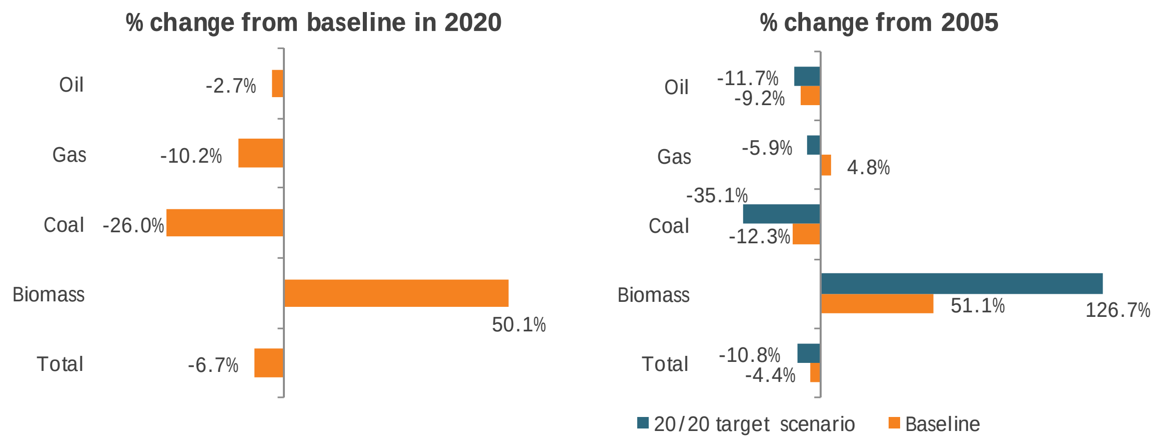
Regarding the allocation of total RES consumption among the different uses, the above figure shows that RES-H consumption is comparable in both sources whereas RES-E (resp. RES-T) consumption is higher (resp. lower) in NREAP than in the *20/20 target* scenario. For RES-E, the gap amounts to 400 ktoe or 4 800 GWh. For RES-T, the difference is lower, around 100 ktoe, which represents approximately 1% of transport energy demand.

1. National Renewable Energy Action Plan (NREAP), November 2010.

4.2.5. Import dependency

The GHG and RES targets also contribute to the realisation of a third objective: the security of energy supply. The substitution in favour of carbon free resources (i.e. RES) and the decrease in energy demand lead to reduced fossil fuel imports. Total energy imports of Belgium go down by 7% compared to the *baseline* in 2020. Relative to 2005, total energy imports are projected to be 11% lower in 2020, whilst in the *baseline*, a decrease of 4% can be noted.

Figure 13: Changes in net energy imports for Belgium, 20/20 target scenario, year 2020



Source: PRIMES.

The changes in the Belgian energy system, which characterize the *20/20 target* scenario, show that the effect on energy demand and development of RES prevails against substitution effects among fossil fuels. For instance, the imposition of a renewable value prevents the substitution from coal to natural gas in the power and heat sector and fosters instead the deployment of RES. As a result, imports of all fossil fuels decrease compared to the *baseline*. The extent of the decline depends, however, on the fossil fuel: -26% from *baseline* in 2020 for coal (the drop comes essentially from the power sector), -10% for natural gas (all sectors seem to cut down on natural gas, with power generation and industry as most important economizers) and -3% for oil. Furthermore, the results show that, in this scenario, the Belgian economy will need less fossil fuels in 2020 than in 2005. In monetary terms, the reduction in oil, gas and coal imports translates into a saving of about 1.2 billion € in 2020 compared to the *baseline* (in € of 2008), when we only consider the decline in oil and gas imports, 1.0 billion € can be economised in this way.

Concerning biomass, the PRIMES model now[30] has a biomass module that is able to provide biomass' costs and prices based on demand-supply curves. Biomass is considered expensive but the price will not increase significantly over the projection period. The model takes into account limited availability of biomass and competition with other uses. In the *20/20 target* scenario, imports of biomass increase by 50% in 2020 compared to the *baseline*. This evolution results into more than a doubling of biomass imports in comparison to the situation in 2005. This outcome must however be put into perspective: the

30 It didn't in the WP 21-08 exercise or at least not as elaborated as it is today. In the WP 21-08, imports of biomass only related to inputs for biofuel production. For all other types of biomass, imports were not modelled and supply came exclusively from national production. In this paper, other inputs are also accounted for (eg. palmoil, wood).

imports of biomass in the *20/20 target* scenario represent no more than 1.3% (0.6 Mtoe) of total (net) energy imports in 2020.

4.3. Impact on GHG emissions

The GHG emissions add up to 116.8 Mt of CO_2 equivalent in Belgium in 2020, 9% down from *baseline* emissions in 2020 (128.4 Mt). This emission level corresponds to a 14% reduction of GHG emissions from 2005 level, instead of a decrease by 5% as projected under the *baseline*.

Table 10: GHG emissions in Belgium, 20/20 target scenario, year 2020

	2020 (Mt CO_2 eq.)	2020-change from baseline (%)	2020 vs. 2005 'domestic reduction' (%)	2020 vs. 2005 'Belgian target (%)
All GHGs	116.8	-9.0	-14.0	-
All CO_2	100.3	-9.9	-14.7	
ETS sectors	45.0	-14.3	-23.0	-
ETS without aviation	40.4	-15.8	-26.0	
Aviation	4.6	2.2	21.2	
Non-ETS sectors	71.8	-5.4	-7.2	-15.0
Energy related CO_2	55.3	-6.0	-6.5	
Non-CO_2 GHGs	16.5	-3.4	-9.6	

Source: PRIMES, GAINS, NTUA.

NB: The allocation of total GHG emissions between ETS and non-ETS is made according to scope '08-12'. The model based emission data differ from the emissions officially reported to the UNFCCC. However, the former are coherent with the model results to 2020 which therefore allow getting insight into the energy-climate policy of Belgium.

CO_2 emissions are projected to be 15% lower than the level of 2005 in 2020. This evolution corresponds to a further decrease by 10% compared to the *baseline* emissions in 2020. Emissions of non-CO_2 GHGs are projected to decline by 10% in 2020 compared to 2005.

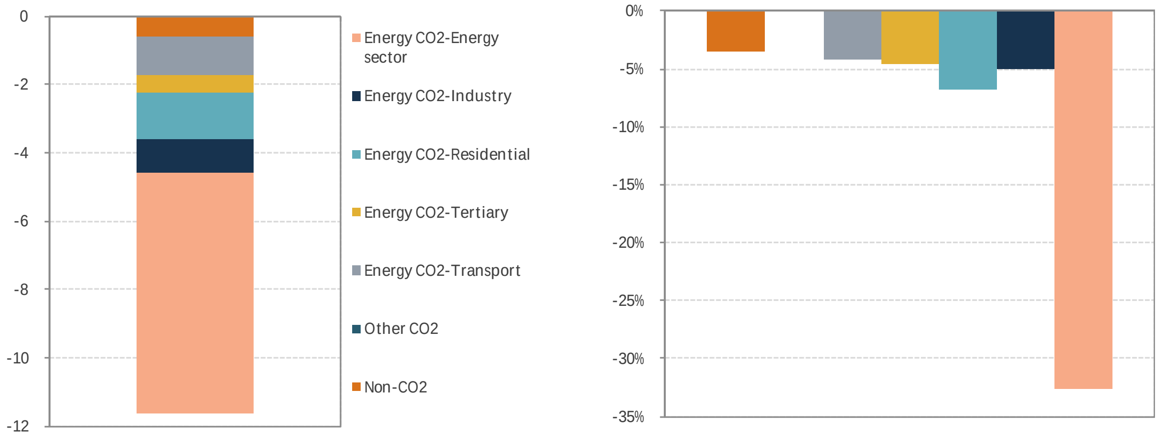
In the ETS sector, which experiences a carbon price of 16.5 €/tCO_2 in 2020, GHG emissions fall by 23% from 2005. In the non-ETS sector with a significantly lower carbon price (5.3 €/tCO_2 in 2020), GHG emissions decrease by 7% compared to the 2005 level.

It is worth underlining that the emission trend in the ETS sector in Belgium is part of the European target of -21% in 2020 compared to 2005. In the Climate-Energy Package, national targets are only specified for the non-ETS sector. The ETS sector is dealt with at the European level. Belgium's target in the non-ETS is -15% in 2020 compared to 2005. Table 10 shows that provided flexibility is fully used in the non-ETS (i.e. uniform non-ETS carbon value across the EU), Belgium would achieve about half of its target domestically (-7.2%).

Compared to *baseline* emissions in 2020, the GHG reduction effort in the ETS and non-ETS sectors boils down to a further 14 and 5% respectively.

Figure 14 shows how the total domestic emission reduction effort is allocated among the sectors (as far as energy related CO_2 emissions are concerned) and among the different categories of GHGs.

Figure 14: GHG emission reductions, 20/20 target scenario, year 2020: difference from baseline
Mt CO_2 eq. (left) and % (right)



Source: PRIMES, GAINS, NTUA.
NB: Transport includes international aviation; energy sector encompasses the power sector and other energy transformation sectors.

The major contributors to GHG emission reductions in Belgium, both in absolute and relative terms, are the energy and the residential sector. In the energy sector, the major part of the reduction takes place in the power sector; it results from fuel switching towards RES and to a lesser extent from a decrease in power production following a drop in electricity consumption. In the residential sector, a partial shift to RES and electricity (heat pumps for heating purposes) combined with large energy savings results in significant CO_2 emission reductions. In industry as well as in transport and tertiary, energy savings and energy efficiency improvement dominate the response of economic agents to the carbon price (and RES value). The changes in fuel mix have a comparatively smaller contribution to CO_2 emission reductions in these sectors.

4.4. Direct cost

4.4.1. Direct (energy) cost related to domestic reduction

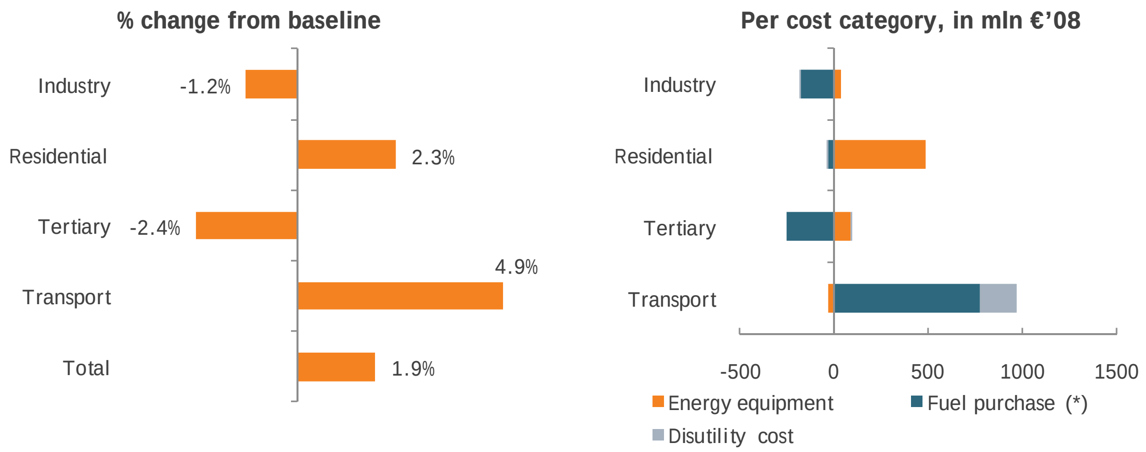
This section describes the direct energy cost of achieving the domestic GHG emission reductions and the domestic RES production defined in the *20/20 target* scenario. This cost encompasses the additional costs, compared to the *baseline*, experienced by Belgian energy users related to the domestic GHG mitigation and renewable energy production efforts as a result of the carbon price and RES value.

The direct energy cost includes the annual payment of investments in RES and energy efficient technologies, the costs related to thermal integrity improvements and rational use of energy not explicitly modelled by technologies as well as stranded costs (when e.g. energy equipments are prematurely replaced), the changes in operation and fuel costs and the costs related to losses of utility for energy services. The latter cost category is also referred to as disutility costs, e.g. the costs of actions to remove barriers to energy efficiency improvement or to adapt energy consumption behaviour. The concept of disutility cost (or hidden cost) is explained in Capros et al., June 2008 Report, pp 27-28. In a nutshell, the disutility cost reflects the evidence from statistics that consumers do not act as expected by engineering-oriented analysis which points to energy savings with zero or even negative costs, the so-called no-regret energy saving potential. This observed behaviour is explained by factors such as lack of information, market barriers, less comfort, etc.

The direct energy cost does, however, not include the cost resulting from mitigation measures for the non-CO_2 GHG and the costs related to flexibility in the non-ETS, on the one hand, and for achieving the RES target, on the other hand.

In 2020, the direct energy cost increases by 1.1 billion €'08 (or by 1.9%) in the *20/20 target* scenario compared to the *baseline*. This amount represents 0.27% of Belgium's projected GDP in 2020. Figure 15 shows cost changes for each final demand sector and how the additional cost is allocated among the three cost categories.

Figure 15: Direct energy cost, 20/20 target scenario, year 2020



Source: PRIMES, NTUA.
(*) Fuel purchase costs relate to all energy sources (fossil, electricity, steam, RES).

In 2020, the domestic effort implemented in the *20/20 target* scenario translates into an increase in direct energy cost by 2.3% in the residential sector and by 4.9% in transport, but into a decrease in direct energy cost by 1.2% in industry and by 2.4% in the tertiary sector. These evolutions take into account the changes in costs in the power and heat sector[31]. Indeed, in the model based evaluation, changes in average power production cost are incorporated in the electricity prices paid by the final consumers, affecting the direct energy cost of the final demand sectors.

The disutility costs represent about 20% of the additional cost; these costs are particularly high in the transport sector. Equipment costs are expected to increase in the residential sector, and to a lesser extent in industry and the tertiary sector. These additional costs are due to the purchase of energy efficient and/or RES-based equipments further to the carbon value in the non-ETS sectors and the RES value. Fuel purchase costs (where fuel encompasses also electricity and steam) show contrasting developments: they decrease in all final demand sectors except in transport.

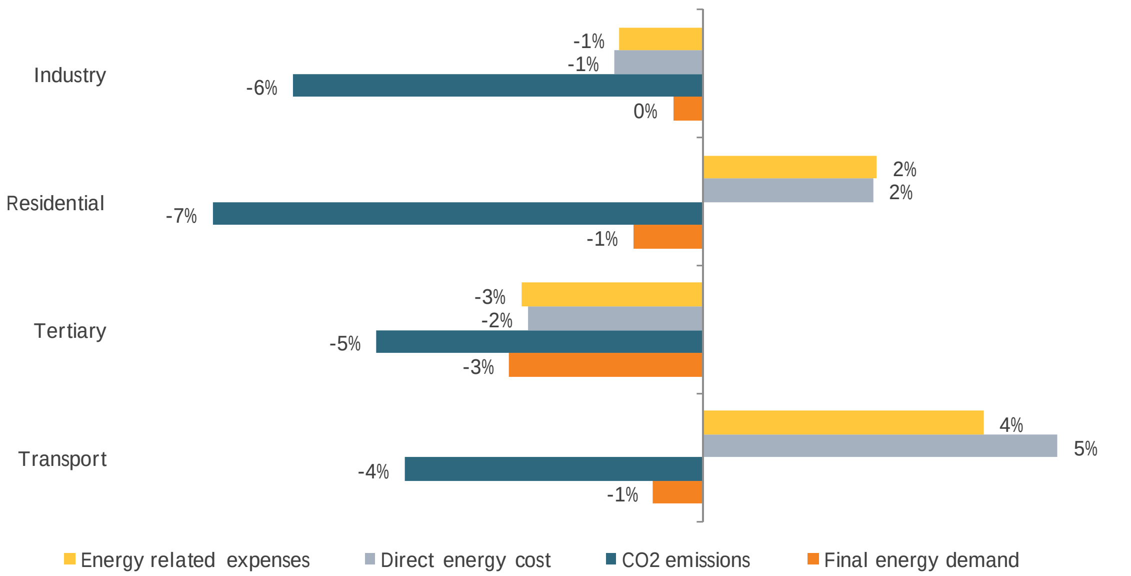
31 E.g. large development of power generation from intermittent renewables entails additional costs for the reinforcement of power grids (and for new grid devices) and for backup power with flexible thermal units. These costs are accounted for in the PRIMES model and are included in the compliance costs.

For industry and the tertiary sector, the overall energy cost decrease comes mainly from the drop in the purchase cost of energy commodities: both sectors experience a fall in fossil fuel and electricity consumption that exceeds the energy cost increases. In transport, the evaluation only involves fuel purchase and disutility costs: the former represents three quarter of the additional cost and the latter the remaining quarter. Fuel purchase costs increase because modal shift and energy savings are not enough to compensate for fuel cost increases (due to the carbon value and biofuels). Finally, the additional cost in the residential sector is dominated by the equipment costs. The increase in equipment costs is due, for the most part, to the rise in RES-based energy equipments (solar water heating, heating systems based on biomass, etc.) and in investments to save energy.

The model-based evaluation of costs is so that changes in electricity prices are related to changes in average electricity production costs. In the *20/20 target* scenario, the power sector faces lower carbon prices than in the *baseline* (16.5 €/t CO_2 vs. 25 €/t CO_2 in 2020) but is influenced by the RES value. All in all, power generation costs slightly decrease compared to the *baseline*: -1% in 2020.

The following figure goes a bit further in the analysis. It puts into perspective the relationship between direct energy costs, energy related expenses and decreases in CO_2 emissions and energy consumption. The difference between direct energy cost and energy related expenses is the disutility cost. Although the disutility cost is a real cost supported by the economic agents or the economy as a whole, it is not, strictly speaking, a spending of the energy consumers. Energy related expenses therefore only encompass energy equipment and fuel costs.

Figure 16: Sectoral indicators, 20/20 target scenario, year 2020
% change compared to baseline



Source: PRIMES, NTUA.

The RES target and the GHG reduction target in non-ETS sectors that both differentiate the *20/20 target* scenario from the *baseline*, induce a remarkable drop in CO_2 emissions (from -4% to almost -7%) and a decrease in final energy demand (ranging from -0.4 to about -3%) for all final demand sectors. The residential and the tertiary sectors fully belong to the non-ETS whereas a share of industry and transport[32] belongs to the EU ETS. The further decrease in CO_2 emissions in the EU ETS is mainly due to the RES target since the ETS carbon price actually reduces in comparison with the *baseline*.

In non-ETS sectors, energy consumers react to the renewable value and to the carbon price by reducing their energy consumption and by switching from fossil fuels to RES. In the residential sector, the significant decrease in CO_2 emissions (-7%) comes mainly from fuel substitution, namely the development of RES and electric heat pumps replacing partly gas and oil boilers for space and water heating. Energy savings play also a role (-1%) but the rather low carbon price (5.3 €/t CO_2) provides little incentives to tap the huge energy saving potential in Belgian households. All in all, energy related expenses per household are estimated to be 90 € up from the baseline in 2020 (in € of 2008). In the tertiary sector, an important energy saving potential (-3%) is identified despite the moderate carbon price whereas fuel substitution possibilities are projected to be small. The shrink in energy related expenses compared to the baseline results from the fact that higher expenses in purchasing more efficient energy equipment are more than counterbalanced by savings in fuel costs (electricity included).

The heavy reliance of transport on petroleum products limits fuel switching to the biofuels and electricity options, as part of the EU Climate-Energy Package. The response of transport to the carbon price goes also through vehicle efficiency improvement and activity reduction. All these changes translate into a decrease in CO_2 emissions (resp. energy consumption) by 4% (resp. 1%).

Finally, the figure above shows not only a decrease in energy demand (-0.4%) and in CO_2 emissions (-6%) in industry, but also a cut in the energy cost (and expenses). These are results for industry as a whole. The impact of the *20/20 target* scenario on CO_2 emissions, energy consumption and cost varies according to the industrial sector. Factors influencing the impact include fuel substitution possibilities (in particular towards RES), ETS vs. non-ETS (the carbon price in (outside) the EU ETS is lower (higher) in the *20/20 target* scenario than in the *baseline*) and the share of electricity consumption (electricity prices are lower in the *20/20 target* scenario compared to the *baseline* – see supra).

4.4.2. Total direct cost

The total direct cost is the sum of the direct cost related to domestic effort and costs related to flexibility. The latter involves the purchase of flexibility in the non-ETS as well as to meet the RES target. Table 11 shows the estimation of the direct cost including flexibility of the *20/20 target* scenario in 2020, i.e. the additional cost compared to the baseline.

Table 11: Total direct cost, 20/20 target scenario, year 2020

		In % of GDP	In million €'08
Cost related to domestic effort	A	0.27	
of which energy related expenses		*0.22*	*900*
Purchase of flexibility in non-ETS	B	0.01	30
Purchase of flexibility for RES target	C	0.03	120
Total direct cost	A+B+C	0.30	1250

Source: PRIMES, NTUA, own calculations.
N.B. Costs presented in the table are additional costs with respect to the *baseline*.

[32] Aviation belongs to the EU ETS.

The cost related to domestic effort encompasses the direct energy cost (see section 4.4.1 above) and the cost resulting from mitigation measures for non-CO_2 GHG. This latter cost category was not estimated in this study. However, the cost analysis presented in Bossier et al (2008) shows that it represents no more than 2% of the total cost related to domestic effort. Therefore, one can reasonably assume that the lack of (up to date) information on mitigation costs for non-CO_2 GHG should not influence much the figures presented in Table 11.

In the non-ETS, GHG emissions are reduced domestically by 7.2% in 2020 from 2005 levels. The gap between these reductions and the Belgium's target (-15%) needs to be filled by means of purchase of CDM credits and/or intra EU trade in emission allowances. Assuming that the CDM/AAU price is the same as the carbon price in the non-ETS (i.e. 5.3 €/t CO_2), the purchase of flexibility is estimated to be 30 million € which is equivalent to 0.01% of the GDP in 2020.

Similarly, the purchase of flexibility for RES production is estimated on the basis of the difference between the target of 13% for Belgium and the domestic RES share of 12.5% and a price equal to the EU average RES value in 2020 (i.e. 49.5 €/MWh). This computation leads to a figure of 120 million € which is equivalent to 0.03% of the GDP in 2020.

All in all, the total direct cost of the *20/20 target* scenario is projected to amount to about 1.2 billion € in 2020, i.e. 0.30% of the GDP in 2020.

4.5. Variant – the 20/20_alt1 target scenario

For the achievement of the non-ETS target, the *20/20 target* scenario assumes that the flexibility provided in the legislation is used by Belgium and the other Member States. This hypothesis, which translates into a uniform carbon value across the EU, leads for Belgium to a domestic reduction of GHG emissions in non-ETS sectors of 7.2% in 2020 compared to 2005, while the objective set is a decrease by 15%. Consequently, Belgium must acquire emission reduction credits abroad in order to bridge the gap between its reduction target and emission reductions achieved domestically.

The aim of this section is to provide an evaluation of the effect of proposed flexibility in the non-ETS sector on GHG emissions as well as on the energy system and related costs. To do so, an alternative scenario (or variant) has been designed that limits the use of flexibility mechanisms in Belgium. In this scenario, called *20/20_alt1 target*, domestic GHG emission reductions in the non-ETS are set equal to -11%[33] in 2020 compared to 2005. This is more than in the *20/20 target* scenario (i.e. -7.2%) but still less than the target (-15%). This scenario is characterized by higher carbon prices in the non-ETS sectors. In 2020, the CV in the non-ETS is evaluated at 41.5 €/t CO_2, against 5.3 €/t CO_2 in the *20/20 target* scenario.

[33] According to the Decision on the non-ETS, Belgium is allowed to use credits from GHG emission reduction projects in third countries up to a quantity representing 4% of its GHG emissions in the non-ETS in 2005. Although Belgium might either maker further use of other flexibility mechanisms and/or not use its possibility to use CDM credits, a domestic reduction effort of 11% in the non-ETS in 2020 (i.e. 15% - 4% = 11%) has been assumed in this scenario.

Impact on GHG emissions

Table 12 below illustrates the impact of a limited use of flexibility in the non-ETS on GHG emissions.

Table 12: GHG emissions in Belgium, 20/20 and 20/20_alt1 target scenarios, year 2020

			20/20 target scenario	20/20_alt1 target scenario
Prices	ETS	CV (€/tCO_2)	16.5	16.5
	Non-ETS	CV (€/tCO_2)	5.3	41.5
	RES	RV (€/MWh)	82.0	82.0
Quantities	Total GHG	wrt 2005 (%)	-14.0	-15.2
		wrt 20/20 target (%)		-1.4
	ETS GHG	wrt 2005 (%)	-23.0	-20.7
		wrt 20/20 target (%)		2.9
	Non-ETS GHG	wrt 2005 (%)	-7.2	-11.0
		wrt 20/20 target (%)		-4.1

Source: PRIMES, NTUA.
wrt = with respect to.

It is interesting to note that imposing a limit on the flexibility in the non-ETS sectors has also an impact on GHG emissions in the ETS. The latter are reduced less between 2005 and 2020 than in the *20/20 target* scenario (-20.7% vs. -23.0%). This result is explained by the difference in CVs. In the *20/20 target* scenario, the CV is much lower in the non-ETS than in the ETS so that fossil fuels in the non-ETS are not penalized much against electricity. In the *20/20_alt1 target* scenario, the CV is much higher in the non-ETS than in the ETS and this favours fuel substitution towards electricity in the non-ETS. A higher consumption of electricity leads to an increase in power generation (net imports of electricity are assumed to remain at the same level throughout all scenarios) and then to a rise in GHG emissions in the ETS. All in all, total GHG emissions are reduced 1 percentage point more in the *20/20_alt1 target* scenario than in the *20/20 target* scenario (-15.2% vs. -14%).

Impact on the energy system

The impact of a limited access to flexibility in the non-ETS on the Belgian energy system (reflected by a higher CV) can be summarized as follows; the impact is provided in percentage change compared to the *20/20 target scenario* in 2020:

- Total final energy demand is projected to be 1.1% lower. Final energy consumption drops particularly in the residential and tertiary sectors. Fossil fuel consumption decreases (-1.8%) whereas electricity demand goes up (+1.6%);
- Power generation rises by 1.8%. The additional production comes mainly from coal power plants (+46%) and to a lesser extent from RES (+2%);
- Gross inland consumption decreases only slightly (-0.3%): the lower demand for fossil fuels in final demand sectors is almost fully compensated by the higher demand for coal in the power generation sector. As a consequence, the impact on net energy imports is minor (-0.4%).

Impact on direct cost

Table 13 shows that reducing domestically GHG emissions in the non-ETS beyond the level achieved in the *20/20 target* scenario – by 11% instead of 7.2% – increases the direct cost of compliance (i.e. the additional cost compared to the baseline). The extra cost is estimated to be some 150 million €'08 in 2020.

Table 13: Total direct cost, 20/20_alt1 target scenario and 20/20 target scenario vs. baseline, year 2020
in million €'08

		20/20 target scenario	20/20_alt1 target scenario
Cost related to domestic effort	A	1100	1300
of which energy related expenses		900	600
Purchase of flexibility in non-ETS	B	30	20
Purchase of flexibility for RES target	C	120	80
Total direct cost	A+B+C	1250	1400

Source: PRIMES, NTUA, own calculations.
N.B. Costs presented in the table are additional costs with respect to the *baseline*.

The boost comes mainly from costs related to domestic effort and more specifically from disutility costs. Indeed, a higher effort domestically in the non-ETS translates into a lower increase in energy related expenses: +600 million €'08 in 2020 vs. +900 million €'08 in the *20/20 target* scenario. This means that the increase in the unit cost of energy (further to a significant increase in the carbon price in the non-ETS) is more than compensated by a drop in energy consumption.

By contrast, the cost associated to the purchase of flexibility is lower than in the *20/20 target* scenario if one assumes that emission credits in the non-ETS are paid at the price of 5.3 €/t CO_2 as in the *20/20 target* scenario.

5. The 30/20 target scenarios

To determine the specifics of the 30/20 target scenarios, inspiration was found in the recently published Commission Staff Working Document SEC(2010) 650 accompanying the communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions *Analysis of options to move beyond 20% greenhouse gas emission reductions and assessing the risk of carbon leakage*. This publication explores the energy and economic impact of moving from a -20% to a -30% obligation. It provides European based carbon and renewable values that, taken together, enable the EU27 to reach the set goals of a -30% GHG reduction and a 20% renewable energy development. However, it does not deal with how the additional effort should be shared amongst the Member States. Without prejudging the "new" GHG reduction targets in the non-ETS if the EU moves to a -30% obligation, the target is assumed to be -21% for Belgium for the impact analysis of the 30/20 target scenarios. This assumption is based on the study described in the above mentioned document. It shows that the percentage reduction in the non-ETS compared to 2005 becomes 16% at EU level (against 10% in the 20/20 target scenario) in order to reach a 30% GHG emission target at lowest possible costs. The 6 percentage points difference between the 20/20 and 30/20 target scenarios was then applied to the Belgian reduction target in the non-ETS, namely -15%, to arrive at -21%. The choice of the GHG reduction target in the non-ETS does not affect much the results as the recourse to flexibility is always possible.

Similarly to the EC Document, two -30% scenarios are analyzed in this Working Paper, one being a scenario in which the EU settles its obligations with the possibility to make use of flexibility mechanisms in the order of 5 percentage points of the target, the other counting on a complete internal EU response to the presented challenges of a stepping up and flexibility only taking place between the European Union's Member States (not outside).

To sum up, the first scenario – referred to as the *30/20_flex target* scenario – is a reduction scenario in which half of the additional reduction effort in greenhouse gas emissions by 2020 compared to 1990 levels is attained domestically at the European level (while the other half can be met through the use of flexibility mechanisms outside the EU) and a 20% share of renewable energy in Gross Final Energy Demand by 2020 is reached for the EU as a whole, including a 10% share of renewable energy in transport in each Member State. The carbon values that match this scenario are shown in Table 14. Both ETS and non-ETS have a CV equal to 30.2 €/tCO_2. The Renewable Value is again equal to 82 €/MWh, which corresponds to a share of 12.8% RES in Gross FED.

The second scenario – referred to in the following as the *30/20_int target scenario* – is a reduction scenario in which the additional 10% reduction to reach the 30% target for greenhouse gas emissions by 2020 compared to 1990 levels takes place at the European level and a 20% share of renewable energy in Gross Final Energy Demand by 2020 is reached for the EU as a whole, including a 10% share of renewable energy in transport in each Member State. The carbon values that match this scenario in a cost-efficient way are also shown in Table 14. The cost-efficiency criteria means that that both ETS and non-ETS have the same CV (55.4 €/tCO_2) which is identical to the EU carbon price. In other words, this scenario allows for the full use of flexibility mechanisms and intra-European trade. Because of the presence of trade and flexibility mechanisms, arbitrage possibilities are exploited causing the carbon values ultimately to level out amongst Member States. The Renewable Value for Belgium was then fixed at 82 €/MWh, which corresponds to a share of 13% RES in Gross FED, fulfilling thereby the Belgian RES objective internally.

Table 14: Carbon and renewable values for Belgium, baseline, 20/20 and 30/20 target scenarios, year 2020

	Baseline	20/20 target scenario	30/20_flex target scenario	30/20_int target scenario
Carbon value - ETS (€/tCO_2)	25.0	16.5	30.2	55.4
Carbon value - non-ETS (€/tCO_2)	0.0	5.3	30.2	55.4
Renewable value (€/MWh)	0.0	82.0	82.0	82.0

Source: NTUA.

Compared to the *baseline* and the *20/20 target* scenario, carbon values are significantly higher for both ETS and non-ETS. This has far reaching implications on the Belgian energy system, as will be discussed in what follows.

In this chapter, the same indicators and graphs as in the *20/20 target* scenario will be analysed, following a similar subdivision. However, the impacts of the 30/20 target scenarios will be described in comparison with the *20/20 target* scenario and not in comparison with the *baseline*. This reasoning is followed in order to assess the effort society has to make to step up to a 30% GHG reduction target at EU level in 2020 given that the 20/20 target pathway is already legally binding. In annex 6.1, detailed energy figures are provided allowing the comparison of the *30/20 target* scenarios with the *baseline*. Important to fully grasp the analyses performed in this part, is to keep in mind that the 30/20 target scenarios also adopt a twin target (GHG emission reduction combined with RES development), no analysis on a single objective is reported in this chapter (nor in the entire study for that matter).

Another important point to make before going into the analysis of scenario results concerns the GHG emission trends beyond 2020 in the different target scenarios. The *20/20 target* scenario focuses on the commitments under the Climate-Energy Package that stick to the year 2020. Beyond 2020, no additional policies or targets are assumed. Consequently, there is not enough incentive to further reduce GHG emissions beyond 2020 and to catch up with the 2°C compatible GHG emission pathway by 2050[34]. By contrast, the 30/20 target scenarios are built so to be consistent with a 2°C compatible emission trajectory for the EU. According to the analysis provided in the Commission staff working document, GHG emissions in the EU should be overall around 40% below 1990 in 2030 for such a trajectory to be cost-efficient. Consequently, a 40% internal reduction in 2030 is assumed in the 30/20 target scenarios.

[34] i.e. limiting expected temperature rise to 2° Celsius above pre-industrial temperature.

5.1. The 30/20 target scenario with flexibility (30/20_flex)

5.1.1. Impacts on the energy system

Gross Inland Consumption

A first impact studied is the effect the carbon and renewable values of the *30/20_flex target* scenario have on Gross Inland Consumption (GIC). One immediate consequence of the stepping up to -30% is the further decrease in total energy requirement. In 2020, the decrease amounts to about 3% compared to the *20/20 target* scenario. This effect concerns all fossil fuels whereas RES consumption remains roughly the same as in the *20/20 target* scenario in large part due to the keeping constant renewable value. Solid fuels support the largest dip, their consumption being cut by 18%. The other fossil fuels also see their demand shrivelled: by 2% for oil and by 3% for natural gas.

Figure 17: Gross Inland Consumption, 30/20_flex target scenario, year 2020
% change compared to the 20/20 target scenario

Source: PRIMES.

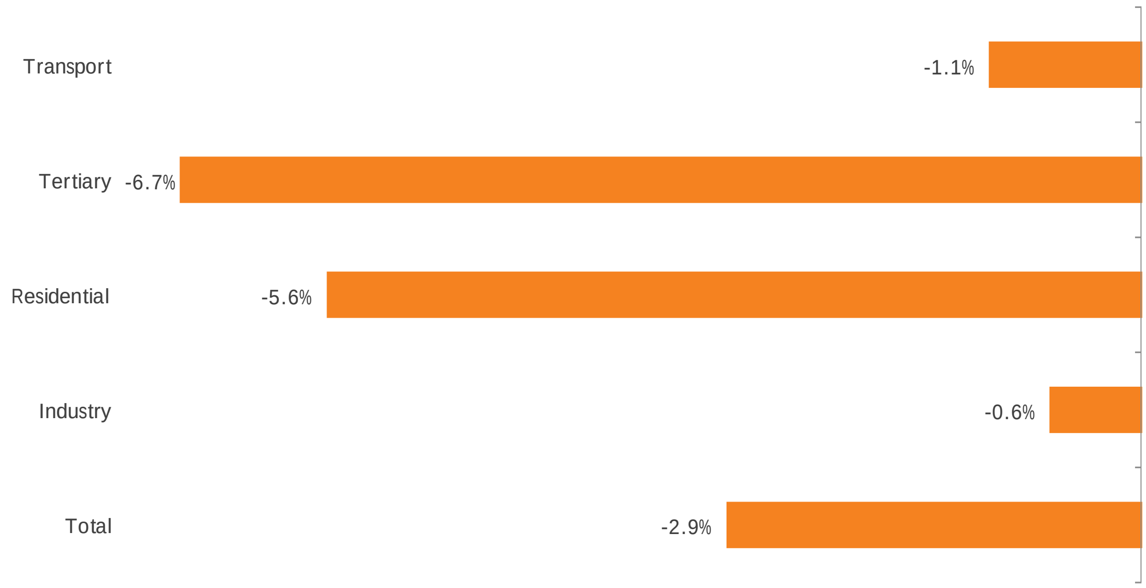
We see that, when a higher GHG target is imposed and combined with a RES objective, both total demand and imports of all fossil fuels, including natural gas, decrease further i.e. compared to the *20/20 target* scenario.

Final Energy Demand

The final energy demand is also affected: it is further cut by 3% in 2020 compared to the *20/20 target* scenario. Tertiary and the residential sector support the biggest consequence of the stepping up of the GHG target with a decrease in final energy consumption in the range of 6 to 7%. By contrast, the impact on industry and transport is rather small (around 1%). Translating these percentages into absolute numbers, we see that energy savings in the residential sector are the biggest (around 600 ktoe), tertiary follows by economising approximately 400 ktoe, whereas transport and industry only cut down by about 100 ktoe.

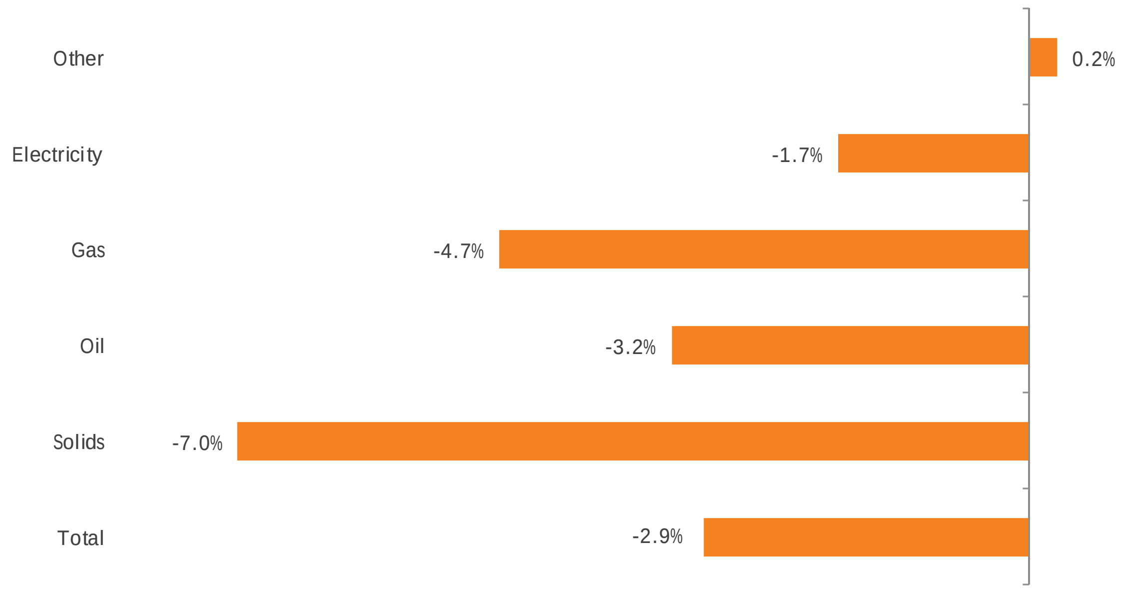
Looking at the same Final Energy Demand but this time decomposed into energy forms, we see that most energy forms are cut back. Solids in particular see their consumption diminished further by 7% due to a rather severe ETS carbon constraint (coal is mainly used in the iron and steel industry). Final electricity consumption is also affected. It steps back with almost 2% in 2020 compared to the *20/20 target* scenario. On the other hand, final demand for renewable energy remains almost unchanged: the same renewable value is used in the 20/20 and 30/20 target scenarios.

Figure 18: Final Energy Demand by sector, 30/20_flex target scenario, year 2020
% change compared to the 20/20 target scenario



Source: PRIMES.
NB: Transport does include aviation.

Figure 19: Final Energy Demand by fuel, 30/20_flex target scenario, year 2020
% change compared to the 20/20 target scenario



Source: PRIMES.
NB: “Other” stands for renewable energy and heat.

Power generation

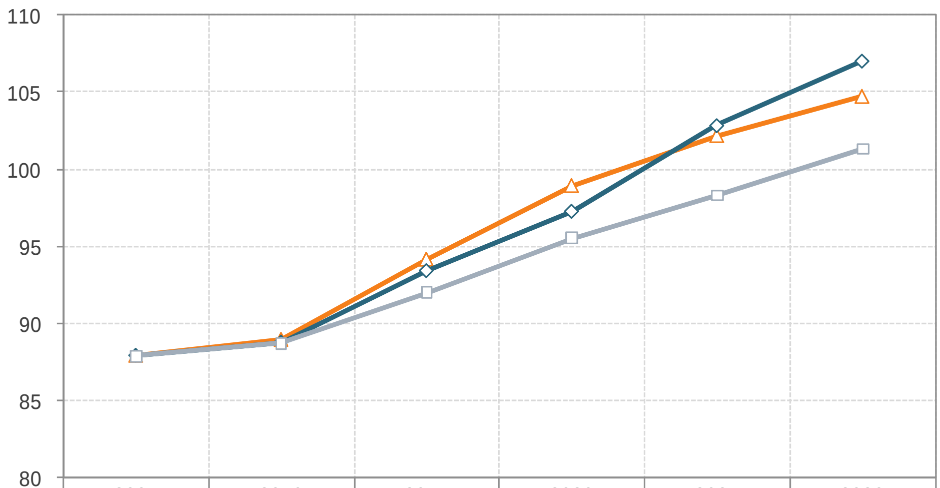
The need for power generation and the demand for electricity are interlinked[35]. The cost of power generation has an impact on the price of electricity, hence on electricity demand which in turn influences the level of power generation.

Important observation is that electricity demand, although increasing, stays under the *baseline* level for the entire period of projection. In contrast to the *20/20 target* scenario, electricity demand thus never recovers to surmount the *baseline* level. It finally arrives, in 2030, at a level that is 3% (resp. 5%) lower than *baseline* (resp. *20/20 target* scenario). Explanation has to be sought in the fact that costs for power generation are superior in the *30/20_flex* target scenario, due to a triple effect: (1) an electricity production based on even more renewable energy sources beyond 2020 (31% of net electricity generation in 2030 against 24% in *baseline* and 28% in the *20/20 target* scenario), (2) the development of CCS from 2020 onwards pushed by the CV and (3) increased price of emission quotas to be purchased due to a significantly higher CV in the ETS sectors (30 and 66 €/tCO_2 in 2020 and 2030 respectively against 25 and 39 €/tCO_2 in *baseline* and 16.5 and 19 €/tCO_2 in the *20/20 target* scenario). This makes electricity comparatively more expensive (compared to the *20/20 target* scenario), leading to a slowed down growth curve for electricity.

All in all, called-up power increases every year by 0.6% on average between 2005 and 2030.

Figure 20: Called-up electrical power, baseline, 20/20 target and 30/20_flex target scenarios, evolution, 2005-2030

TWh

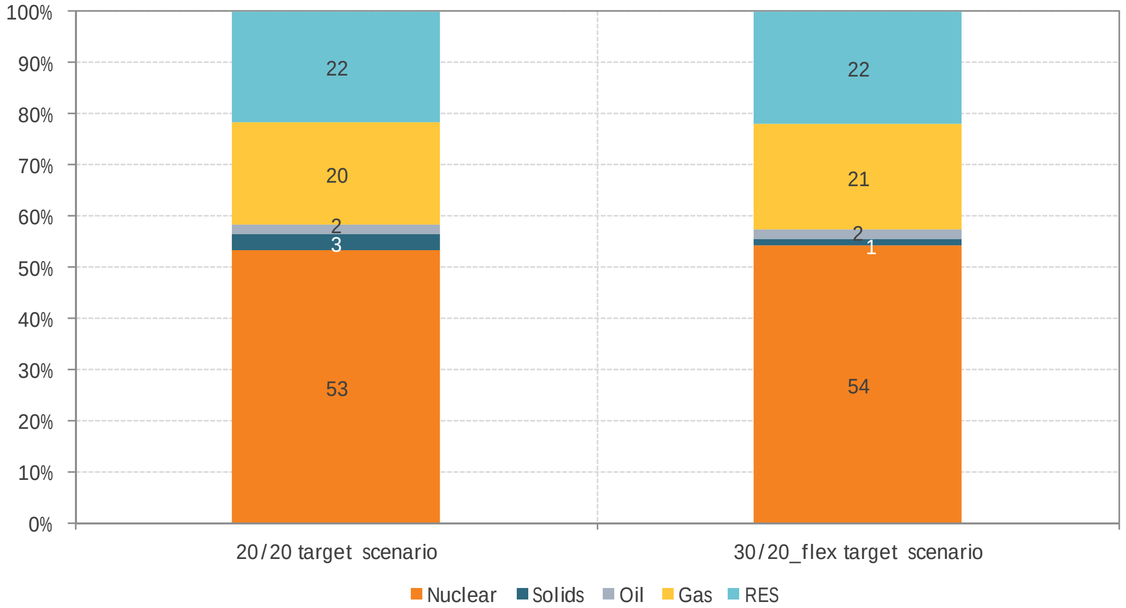


	2005	2010	2015	2020	2025	2030
Baseline	88	89	94	99	102	105
20/20 target	88	89	93	97	103	107
30/20_flex target	88	89	92	96	98	101

Source: PRIMES, own calculations.
N.B. 2010 figures are projections, not statistics.

[35] It is worth recalling that imports of electricity are exogenously determined and do not change according to the scenario.

Figure 21: Net electricity generation, 30/20_flex target scenario vs. 20/20 target scenario, year 2020
%



Source: PRIMES.

It is assumed that the demand for electricity is satisfied through a corresponding generation of power (taking into account the level of net imports). In total, 84.4 TWh are produced in 2020 (compared to 86.2 TWh in the *20/20 target* scenario). The figure refers to net electricity production. The fuel mix is however comparable to that in the *20/20 target* scenario despite the fact that coal looses 2 percentage points at the (equal) benefit of natural gas and nuclear.

To wrap up the situation in the power sector, Table 15 shows a selection of sector specific indicators for the *30/20_flex target* scenario, next to the ones in the *20/20 target* scenario.

Table 15: Indicators related to the power generation sector, 30/20_flex target scenario vs. 20/20 target scenario, year 2005 and 2020

	2005	2020 20/20 target	2020 30/20_flex target
Efficiency for net thermal electricity production (%)	40.5	41.2	41.9
Net imports ratio (%)	6.9	11.4	11.6
% net electricity from CHP	9.0	16.3	18.0
% electricity from RES	4.1	21.6	22.0
Share of non-fossil fuels in net power generation (%)	59.1	74.7	76.2
Net installed power capacity (GW)	14.7	20.7	20.6
Carbon intensity (tCO_2/GWh)	230	111	95
Electricity (final demand) per capita (kWh/capita)	7675	7889	7756

Source: PRIMES.

The evolution of the average efficiency of thermal electricity production is closely related to the technology mix. Figures are comparable between 2005 and 2020 and between *20/20 target* and *30/20_flex target* scenario as the thermal technology mix does not change radically over time and over scenario. The indicator is however marginally more elevated (+0.7 percentage points) in the *30/20_flex target* scenario compared to the *20/20 target* scenario, owing to the fact that more gas and less coal are used[36] in the former.

The net imports ratio is the ratio between net imports and total electricity supply. It increases over time because of growing net imports in both scenarios. The level of net imports is exogenously fixed and does not change according to the scenario. In 2020, the slight difference between the two target scenarios has only to do with total electricity supply (see supra).

The share of non-fossil fuels in electricity production combines two elements: nuclear on the one hand, renewable energy sources on the other. As the entire nuclear power park, representing around half of total Belgian electricity provision in 2005, is assumed to stay available in 2020, the share of nuclear energy stays quasi unchanged throughout the 2005-2020 period. On the other hand, the share of renewable energy sources keeps on climbing: it reaches the same percentage (i.e. 22%) by 2020 in the *30/20_flex target* scenario as in the *20/20 target* scenario.

The share of CHP in electricity generation (covering both fossil fuel and biomass based cogeneration) increases slightly from 16% in 2020 in the *20/20 target* scenario to 18% in the *30/20_flex target* scenario as CHP is an excellent tool to combine both efficient and less (or even not, in the case of RES based CHP) polluting power production.

The net installed power capacity increases by 40% over the period 2005-2020 in the *30/20_flex target* scenarios; this is slightly less than in the *20/20 target* scenario (41%). The power capacity increases at a higher pace than electricity demand (+9% over the same period). Reason has to be searched in the decrease in average utilisation rate of electrical capacities: in 2005, it was around 64%; in 2020, it is estimated to be 47% in the *30/20_flex target* scenario[37].

The table below depicts the net power generation and capacity from RES in the *30/20_flex target* scenario in the year 2020, as well as the percentage of change compared to the *20/20 target* scenario for that same year. Globally, both target scenarios show the same pattern. The only difference concerns the biomass/waste power capacity: it is projected to be 3% lower in *the 30/20_flex target* scenario than in the *20/20 target* scenario in 2020. This drop reflects a slightly higher utilisation rate of biomass based power plants in the former scenario.

Table 16: RES net power capacity and net electricity generation in the 30/20_flex target scenario, year 2020

	Net power capacity (MW)		Net electricity generation (GWh)	
	2020	% change compared to 20/20 target	2020	% change compared to 20/20 target
Hydro	138	0%	404	0%
Wind	3659	0%	10342	0%
Biomass and waste	2012	-3%	7517	0%
Solar PV	309	0%	299	0%
Total	6118	-1%	18562	0%

Source: PRIMES, own calculations.

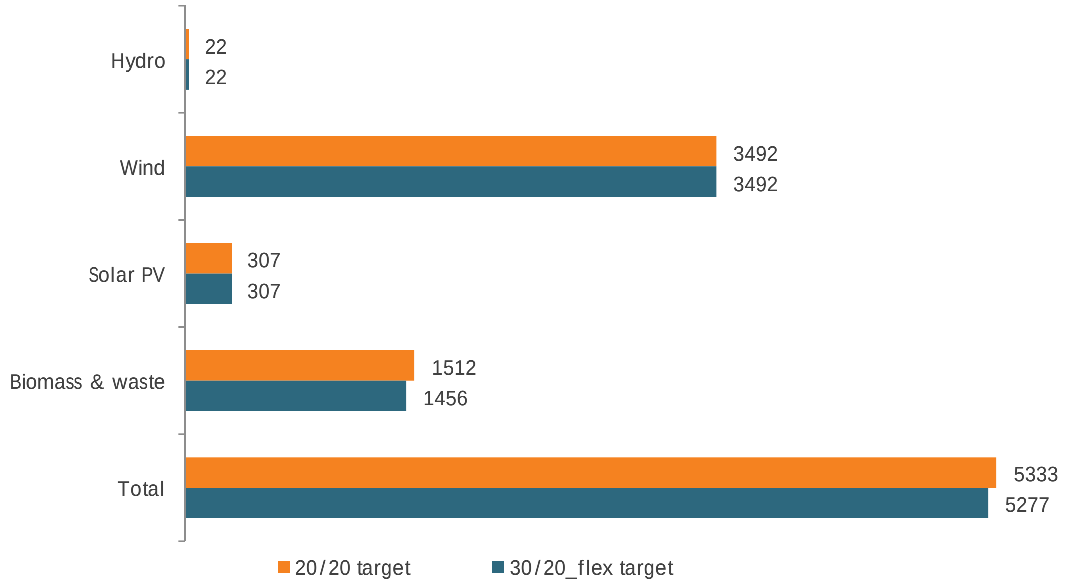
36 Gas (especially combined cycle gas turbines or CCGTs) is characterized by a higher conversion efficiency (close to 60% for new generation) than coal (around 50% for supercritical coal power plants).

37 The decrease in average utilisation rate (i.e. generation/(installed capacity x 8760 hours)) is due to the higher share of power capacities based on intermittent energy sources such as wind and solar.

Figure 22 shows the additional net installed RES power capacity for the *20/20* and *30/20_flex target* scenarios. Once again, we see that the stepping up to -30% does not affect much the investments in RES capacity for electricity production, if flexibility is allowed for meeting the GHG target.

Figure 22: Net installed RES power capacity, 20/20 target and 30/20_flex target scenarios, year 2020: difference from 2005

MW



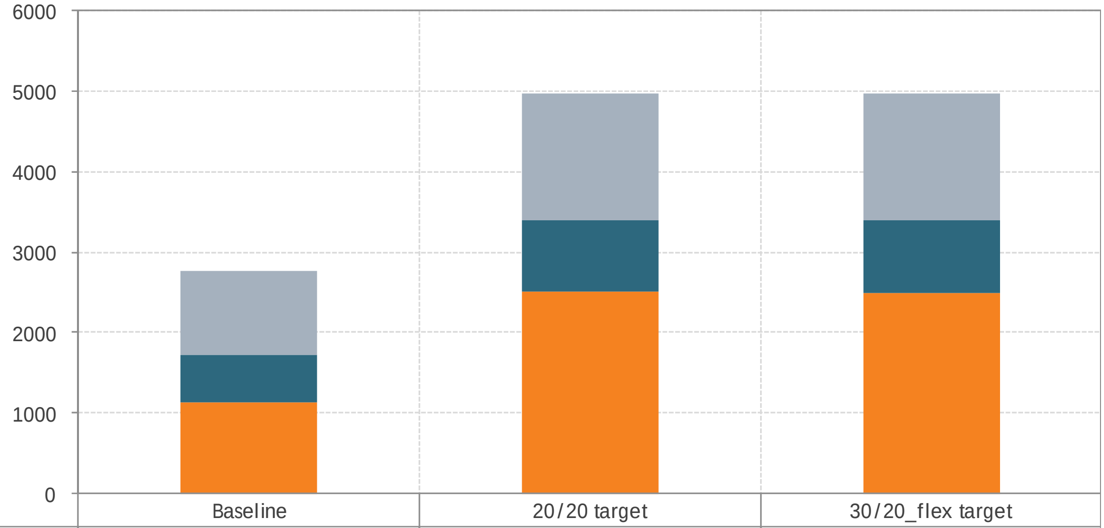
Source: PRIMES.

RES in Gross Final Energy Demand

After this overview of renewable energy forms within the power sector, we follow a more general approach to determine the total share of RES in Gross Final Energy Demand in the *30/20_flex target* scenario. A 13% share in Gross FED in Belgium should be reached by 2020 according to RES Directive 2009/28/EC. In the *20/20 target* scenario, we saw that a 12.5% share or some 4 900 ktoe (approx. 58 TWh) is obtained in 2020 through a RV of 82 €/MWh. The *30/20_flex target* scenario, with the same RV, steps up this effort somewhat and reaches 12.8% due to a slightly lower level of gross final energy demand. Figure 23 then splits up the different uses (heating and cooling[38], transport and electricity, or RES-H, RES-T and RES-E). It shows that the stepping up to -30% - with flexibility - does not lead to major changes in the structure and level of RES consumption compared to the *20/20 target* scenario.

[38] As it does not seem trivial to estimate the amount of renewable energy consumed by heat pumps (due to an apparent absence of threshold, the lack of data on the existing stock of heat pumps and their average coefficient of performance), the contribution of heat pumps to RES-H is not taken into account. This causes a (slight) underestimation of (the percentage of) RES-H.

Figure 23: Renewables in Gross Final Energy Demand, baseline, 20/20 target and 30/20_flex target scenarios, year 2020
ktoe



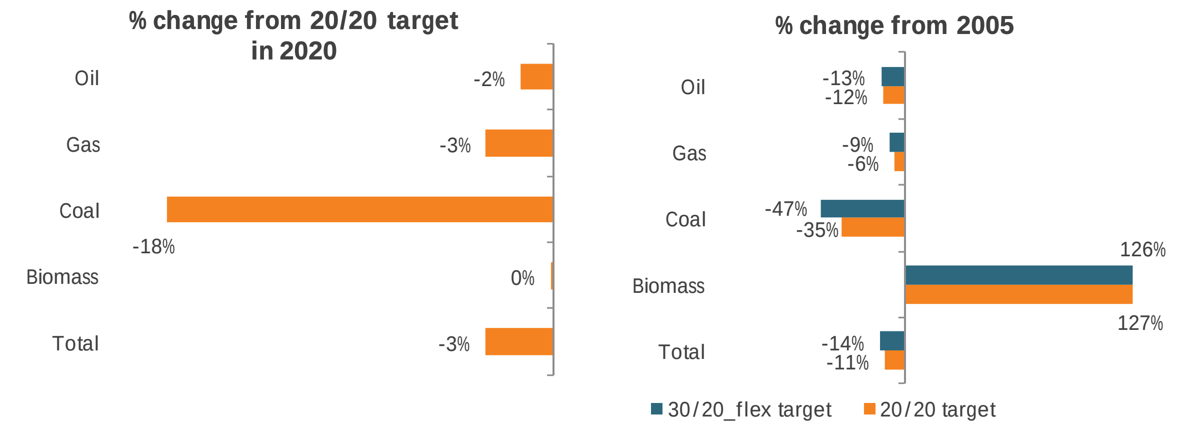
	Baseline	20/20 target	30/20_flex target
RES-E	1056	1576	1575
RES-T	585	900	896
RES-H	1130	2505	2500

Source: PRIMES.
NB: RES-H encompasses at the same time the heat produced in biomass-based CHP as the biomass' and solar heat used for space and water heating.

Import dependency

The *30/20_flex target* scenario should further improve the security of our energy supply. The decrease in energy consumption compared to the *20/20 target* scenario leads to reduced fossil fuel imports. Total energy imports go down by 3% from *20/20 target* scenario level in 2020. Relative to the year 2005, total energy imports are projected to be 14% lower in 2020, whilst the decrease in the *20/20 target* scenario amounts to 11%.

Figure 24: Changes in net energy imports of Belgium, 30/20_flex target scenario, year 2020



Source: Eurostat, PRIMES.

The changes in the Belgian energy system which characterize the *30/20_flex target* scenario bring about that the effect on energy demand prevails against fuel substitution effects. Imports of all fossil fuels decrease compared to the *20/20 target* scenario. The extent of the decline depends, however, on the type of fossil fuel. Coal drops the most significantly (-18%) compared to the *20/20 target* scenario level in 2020, mainly due its disadvantaged position in the power generation sector. The decline amounts to 3% for natural gas and to 2% for oil. It results mostly from energy efficiency gains in the tertiary and domestic sectors. By contrast, imports of biomass in 2020 remain at the same level as in the *20/20 target* scenario.

In monetary terms, the reduction in oil, gas and coal imports translates into a saving of about 0.5 billion € in 2020 compared to the *20/20 target* scenario (in € of 2008); when we only consider the decline in oil and gas imports, 0.4 billion € can be economised.

5.1.2. Impact on GHG emissions

The GHG emissions add up to 110.8 Mt of CO_2 equivalent in Belgium in 2020, 5% down from 2020 emissions in the *20/20 target* scenario (116.8 Mt). This emission level corresponds to a 18% reduction of GHG emissions from 2005 level, instead of a decrease by 14% as projected under the *20/20 target* scenario.

Table 17: GHG emissions in Belgium, 30/20_flex target scenario

	2020 (Mt CO_2 eq.)	2020 change from 20/20 target (%)	2020 vs. 2005 'domestic reduction' (%)	2020 vs. 2005 'assumed target' (%)
All GHGs	110.8	-5.1	-18.4	-
All CO_2	95.5	-4.8	-18.8	
ETS sectors	42.4	-5.9	-27.5	-
ETS without aviation	37.9	-6.1	-30.6	
Aviation	4.4	-3.7	16.7	
Non-ETS sectors	68.5	-4.7	-11.5	-21%(*)
Energy related CO_2	53.1	-4.0	-10.2	
Non-CO_2 GHGs	15.4	-6.8	-15.8	

Source: PRIMES, GAINS, NTUA.

NB: The allocation of total GHG emissions between ETS and non-ETS is made according to scope '08-12'. The model based emission data differ from the emissions officially reported to the UNFCCC. However, the former are coherent with the model results to 2020 which therefore allow getting insight into the energy-climate policy of Belgium.

(*): The figure of -21% is arbitrary. It is not a suggestion for an updated reduction target in the non-ETS.

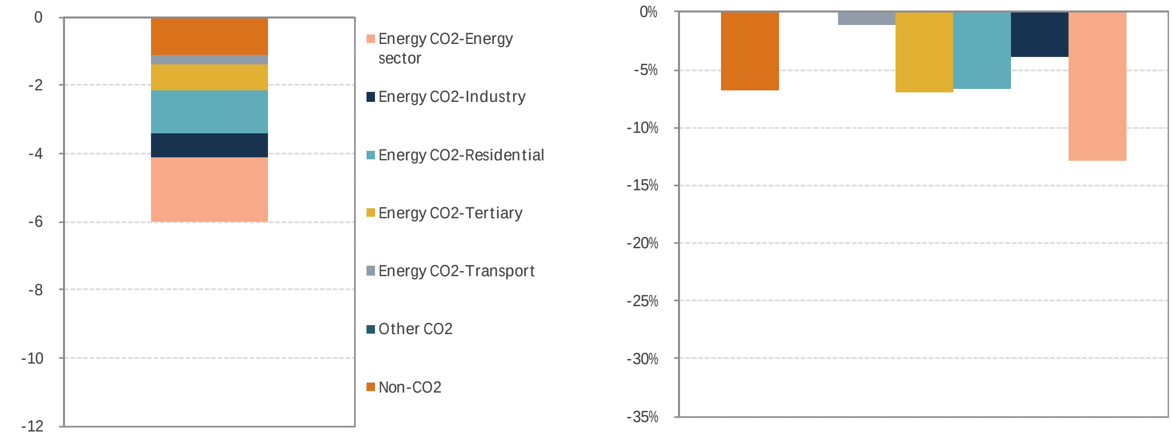
In 2020, CO_2 emissions are projected to be 19% lower than the level of 2005. This evolution corresponds to a further decrease by 5% compared to the emissions in the *20/20 target* scenario. The emissions of non-CO_2 GHGs are projected to plunge by 16% in 2020 compared to 2005.

In the ETS sector, which experiences a carbon price of 30 €/tCO_2 in 2020, GHG emissions decline by 27.5% from 2005 in 2020. The non-ETS sector, having a similar carbon price, depicts a lower reduction percentage: in 2020, GHG emissions are reduced by almost 12% compared to 2005. It is worth to underline that the emission trend in the ETS sector in Belgium is part of the European target.

Table 17 only relates to emission reductions realized domestically. Access to CDM in the ETS and the non-ETS sectors allows Belgium to achieve further GHG emission reductions. In the non-ETS sector, no specific target is (yet) proposed in case of a European effort increase in GHG reductions to -30%. We assume a reduction percentage of 21% (see p.38).

Figure 25 shows how the emission reduction effort realized domestically on top of reductions already achieved in the *20/20 target* scenario, is allocated among the sectors (for energy related CO_2 emissions) and among the different categories of GHGs.

Figure 25: GHG emission reductions, 30/20_flex target scenario, year 2020: difference from 20/20 target scenario
Mt CO_2 eq. (left) and % (right)



Source: PRIMES, GAINS.
NB: Transport includes international aviation; energy sector encompasses the power sector and other energy transformation sectors.

In case of a stepping up to -30% with flexibility, the major contributor to further GHG emission reductions in Belgium, both in absolute and relative terms, is the energy sector where the major part of the reduction takes place in the power sector and relates to CO_2 emissions. The *30/20_flex target* scenario is also characterized by CO_2 emission reductions in the residential and tertiary sectors and by a decline in non-CO_2 emissions of equal magnitude, namely 7% in 2020 compared to the *20/20 target* scenario.

5.1.3. Economic cost

The evaluation of the economic cost for Belgium of stepping up to -30% involves two complementary approaches. The first approach relies on the assessment of the direct cost (section 0) which encompasses two components: (1) the direct (energy) cost related to domestic effort evaluated with PRIMES and (2) the cost related to flexibility. The second approach deals with the macroeconomic impact of moving towards a 30% GHG reduction target at EU level; it relies on the HERMES model.

Direct cost

Direct (energy) cost related to domestic reduction

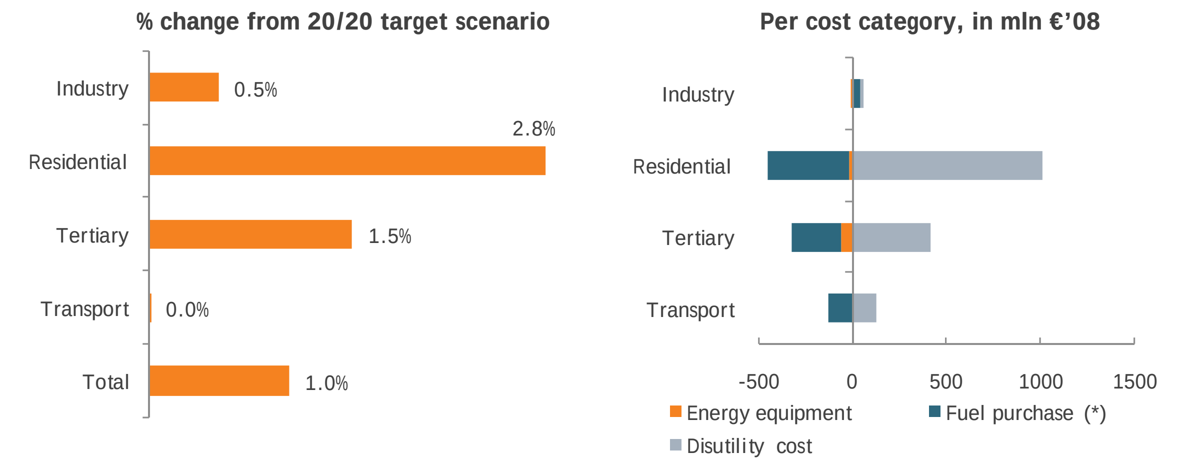
This section describes the direct energy cost of achieving the domestic GHG emission reductions and the domestic RES production defined in the *30/20_flex target* scenario. This cost encompasses the additional costs, compared to the *20/20 target* scenario, experienced by Belgian energy users related to the domestic mitigation and renewable energy production efforts as a result of the carbon prices and RES value.

The direct energy cost includes the annual payment of investments in RES and energy efficient technologies, the costs related to thermal integrity improvements and rational use of energy not explicitly modelled by technologies as well as stranded costs (when e.g. energy equipments are prematurely replaced), the changes in operation and fuel costs and disutility costs e.g. the costs of actions to remove barriers to energy efficiency improvement or to adapt energy consumption behaviour (see Capros, 2008).

The direct energy cost does, however, not include the cost resulting from mitigation measures for the non-CO_2 GHG and the costs related to flexibility in the non-ETS, on the one hand, and for achieving the RES target, on the other hand.

In 2020, the direct energy cost increases by some 0.7 billion €'08 (or by 1.2%) in the *30/20_flex target* scenario compared to the *20/20 target* scenario. This amount represents 0.17% of Belgium's projected GDP in 2020. Figure shows cost changes in each final demand sector and how the extra cost is allocated among the three cost categories.

Figure 26: Direct energy cost, 30/20_flex target scenario, year 2020



Source: PRIMES, NTUA.
(*) Fuel purchase costs relate to all energy sources (fossil, electricity, steam, RES).

In 2020, the additional domestic effort implemented in the *30/20_flex target* scenario translates into an increase in direct energy cost by almost 3% (resp. 2%) in the residential (resp. tertiary) sector, and into a moderate grow (below 1%) in industry and transport. These evolutions take into account the changes in costs in the power and heat sector[39]. Indeed, in the model based evaluation, changes in average power production cost are incorporated in the electricity prices paid by the final consumers, affecting the direct energy cost of the final demand sectors.

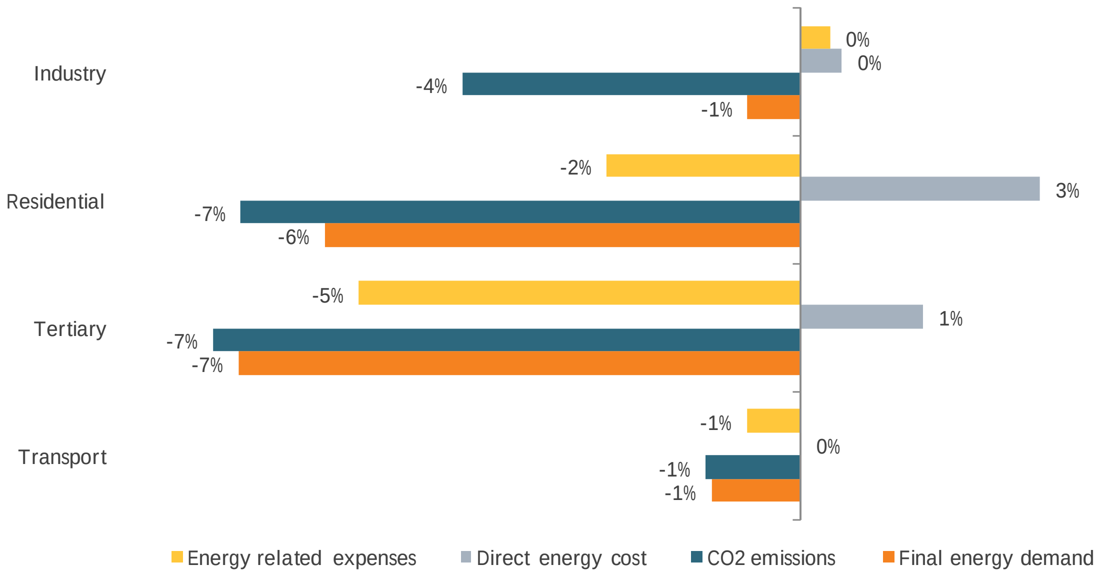
The additional cost results from the significant increase in disutility costs whereas fuel and equipment costs drop compared to the *20/20 target* scenario. Disutility costs climb particularly strongly in the residential sector, followed by the tertiary sector and transport. Fuel purchase costs decrease in all final demand sectors except in industry though moderately. In the latter case, fuel purchase costs go up because fuel switching and energy savings are not high enough to compensate for fuel cost increases

39 E.g. large development of power generation from intermittent renewables entails additional costs for the reinforcement of power grids (and for new grid devices) and for backup power with flexible thermal units. These costs are accounted for in the PRIMES model and are included in the compliance costs.

(due to the CV)[40]. Finally, the stepping up to -30% has only a slight impact on equipment costs.

The following figure goes a bit further in the analysis. It puts into perspective the relationship between direct energy costs and decreases in CO_2 emissions and energy consumption compared to the *20/20 target* scenario. The difference between direct energy costs and energy related expenses is the disutility cost. Although the disutility cost is a real cost supported by the economic agents or the economy as a whole, it is not, strictly speaking, a spending of the energy consumers. Energy related expenses therefore only encompass energy equipment and fuel costs.

Figure 27: Sectoral indicators, 30/20_flex target scenario, year 2020
% change compared to 20/20 target scenario



Source: PRIMES, NTUA.

Figure 27 shows that the stepping up to -30% goes hand in hand with a further decrease in energy consumption, especially in the residential and tertiary sectors, which translates afterwards into a drop of energy related expenses. CO_2 emissions in the residential and tertiary sectors decrease by 7% in 2020 compared to the *20/20 target* scenario. The effect is less marked for industry (-4%) and transport (-1%). Results show also that energy saving is the main answer of the residential and tertiary sectors to the strengthening of the GHG emission target, whereas fuel switching does the trick in industry.

Total direct cost

The total direct cost is the sum of the direct cost related to domestic effort and costs related to flexibility. The latter involves the purchase of flexibility in the non-ETS as well as to meet the RES target. Table shows the estimation of the direct cost including flexibility of the *30/20_flex target* scenario in 2020, i.e. the additional cost compared to the *20/20 target* scenario.

[40] The decrease in final energy demand is lower than 1% in industry while it is in the range of 6 to 7% in the residential and tertiary sectors (see section 0).

Table 18: Total direct cost, 30/20_flex target scenario, year 2020 (compared to the 20/20 target scenario)

		In % of GDP	In million € '08
Cost related to domestic effort	A	0.17	700
Of which energy related expenses		*-0.21*	*-850*
Purchase of flexibility in non-ETS	B	0.04	190
Purchase of flexibility for RES target	C	-0.01	-60
Total direct cost	A+B+C	0.20	830

Source: PRIMES, NTUA, own calculations.
N.B. Costs presented in the table are additional costs with respect to the *20/20 target* scenario.

The cost related to domestic effort encompasses the direct energy cost and the cost resulting from mitigation measures for non-CO_2 GHG. This latter cost category was not estimated in this study (see section 4.4.2).

In the *30/20_flex target* scenario, the cost related to the purchase of flexibility in the non-ETS is evaluated assuming that the non-ETS GHG target for Belgium will be a reduction by 21% in 2020 compared to the 2005 level[41] (against 15% in the *20/20 target* scenario according to the burden sharing directive) and that the price of flexibility in the non-ETS is upper bounded to a figure of 30 €/t CO_2. The additional cost resulting from the stepping up to -30% is then calculated as the difference between the above cost and the corresponding cost in the *20/20 target* scenario. This calculation leads to an additional cost of almost 200 million € which is equivalent to approximately 0.04% of the GDP in 2020.

The purchase of flexibility for RES production is estimated on the basis of the difference between the domestic RES shares in the 30/20_flex and 20/20 target scenarios and a price equal to the EU average RES value in 2020 (i.e. 49.5 €/MWh). This computation leads to a negative[42] cost of 60 million € which is equivalent to nearly 0.01% of the GDP in 2020.

All in all, the total direct cost of stepping up to -30% is projected to amount to about 0.8 billion € in 2020, i.e. 0.20% of the GDP in 2020. It is worth underlining that the large part of this cost is due to disutility costs. Indeed, if one sticks to energy related expenses, the table shows a decrease compared to the *20/20 target* scenario in 2020 (-850 million €'08). This result indicates that the increase in the unit cost of energy (further to higher carbon prices in both ETS and non-ETS) is more than offset by the decrease in energy consumption.

Macroeconomic impact

As stressed in the previous sections, the direct cost does not account for the feedback effects on the Belgian economy and its sectors, which were evaluated by means of the HERMES model and whose results follow. The *30/20_flex* target scenario will be evaluated according to two options regarding the recycling of new public receipts generated by the stepping up to the -30% GHG EU objective: either no recycling of new public receipts (which contribute then to decrease the public debt) or recycling of both the additional auctioning revenues (from the ETS sector) and the additional carbon tax receipts (from the non-ETS sector) in reduction of social contributions paid by employers. The results of these two recycling options indicate a possible range of the impacts on the Belgian economy. The macroeconomic

[41] See Bossier et al. (2008).

[42] The cost is negative because the domestic RES share is higher in the *30/20_flex target* scenario (12.8%) than in the *20/20 target* scenario (12.5%).

impacts of the *30/20_flex* target scenario will be presented in comparison with the *20/20 target* scenario, except when stated otherwise.

First of all, it is worth describing the *ex ante* effects of the *30/20_flex* target scenario, i.e. the impact on energy prices, the increase in public receipts and the modification of the international context.

The following table presents the *ex ante* impacts of the introduction of the carbon values on the main energy prices. It refers to (all taxes included) prices paid by the final consumer and calculated by the energy module of HERMES, except electricity prices which are provided by PRIMES.

As can be seen, the impact relies on the carbon content of the product, but also on the initial level of the energy product price (and consequently on the taxation policy of the public authorities). The impact is high for solid fuels (which have a high carbon content) and relatively low for electricity, gasoline, diesel oil and natural gas for industry. All in all, the average energy price would increase by 4.7% in 2020 above the *20/20 target* scenario level. For households, the increase would be of the same magnitude.

Table 19: Ex ante impacts of carbon values on energy prices, 30/20_flex target scenario
% change from 20/20 target scenario

	2013	2017	2020
Solid fuels			
(a) Households and services	10.8	17.0	17.5
(b) Industry	13.9	27.6	32.7
Liquid fuels			
(a) Gasoline	2.5	4.5	5.0
(b) Diesel oil	3.4	5.8	6.1
c) Fuel for heating	6.8	11.2	11.7
(d) Heavy fuel	5.7	9.8	10.7
Natural gas			
(a) Industry	3.3	5.7	6.3
(b) Services	5.7	9.7	10.2
(c) Households	4.9	8.5	9.1
Electricity			
(a) High tension	0.4	0.8	1.2
(b) Low tension	3.4	4.7	3.4
Average energy price	2.7	4.7	4.7
Of which households	2.8	4.9	4.6

The *30/20_flex target* scenario implies a non negligible *increase in public receipts*[43], coming from the introduction of a higher carbon value (e.g. CO_2 tax) in the non-ETS sector and from the auctioning rights paid by a part of the ETS sector[44]. As shown in Table 20, the additional public revenues amount to about

43 The increase in public receipts is computed as the additional public receipts generated by the moving from the 20% EU GHG reduction target scenario (*20/20*) to a 30% GHG reduction target (*30/20_flex*) at EU level in 2020. At the European level, the additional auctioning receipts resulting from the stepping up from the 20% EU GHG reduction target scenario (*20/20*) to a 30% GHG reduction target (*30/20_flex*) would amount to about 24 billion € in 2020.

44 At this stage, it is difficult to assess precisely the impact of the allocation rules for the ETS rights. The following assumptions have been made. The auctioning rights paid each year by the ETS sectors consist in a share of their respective emissions in the current year. This share rises linearly from 20% in 2013 to 70% in 2020. The percentage of the ETS industry paying auctioning rights was approximated to 10% and represents the sectors that are the least subject to CO_2 leakage. The remaining 90% of the ETS sector do not pay any auctioning rights. As for the power generation sector, it pays 100% of its auctioning rights on the whole period.

2.4 billion (or 0.48% of GDP) in 2020. 530 millions are estimated to come from the auctioning of emission rights in the ETS sector, the remaining 1.87 billion resulting from the taxation in the non-ETS sector. It is worth noticing that the purchase related to the use of flexibility mechanisms by the non-ETS sector is deducted from those public receipts amounts.

Table 20: Additional public receipts generated by the moving from the 20/20 target scenario to the 30/20_flex target scenario
in bn €

	2013	2017	2020
(1) Industry (auctioning)	0.20	0.43	0.53
(2) Industry (NETS) + Services	0.39	0.70	0.73
(3) Households (lighting, heating)*	0.36	0.49	0.38
(4) Transport	0.35	0.66	0.76
(a) Households	0.14	0.26	0.30
(b) Firms	0.22	0.40	0.46
Total	1.30	2.27	2.40
In % of GDP	0.34	0.51	0.48

(*): Cost of flexible instruments deducted.

An important aspect of the simulations concerns the *modification of the international environment*. Indeed, the scenario under study concerns the whole of Europe and would consequently have an effect on the EU economy as a whole and, thus, on our trading partners. In this context, the European macro-econometric model NEMESIS was used to compute the effects of this policy on the different economies and, thus, the effects on the Belgian export market and on the import and export prices. The impacts are given in Table 21, both for the no recycling simulation (left part) and for the simulation where all public revenues are recycled in reductions of social contributions paid by employers (right part). In the case of no recycling of public receipts, the potential export market for Belgium would diminish by about 1% compared to a scenario wherein GHG emissions are cut by 20% at EU level. It appears that, in case of public receipts recycling, impacts are less important.

Table 21: Impact on potential export market and on import and export prices, 30/20_flex target scenario
% change from 20/20 target scenario

target scenario	No recycling of public receipts			Full recycling of public receipts		
	2013	2017	2020	2013	2017	2020
Potential export market	-0.26	-0.93	-1.01	-0.18	-0.57	-0.62
Import prices for Belgium	0.16	0.40	0.29	0.04	0.07	0.06
Export prices for Belgium	0.11	0.18	0.04	0.00	-0.10	-0.15

The macroeconomic impact of the *30/20_flex target* scenario is now presented according to the two recycling options: no recycling of new public receipts and full recycling of new public receipts in reduction of social contributions paid by employers.

No recycling of new public receipts

In this simulation, the net additional auctioning and tax revenues collected thanks to the transition from the *20/20 target* scenario to the *30/20_flex target* scenario are not invested in the economy but come as a net addition to the public finances. This simulation is named the *no recycling policy*.

Table 23 (left part) presents the results of the scenario simulated by HERMES. Results are given for 2013, 2017 and 2020. Unless stated otherwise, figures refer to the percentage change between the results of the *30/20_flex target scenario* and the *20/20 target* scenario levels.

The increase in energy prices has negative effects on the economic activity, which is also affected by the expected decrease in potential markets. As new public revenues are not recycled, they cannot mitigate this economic downturn. In 2013, GDP is 0.08% lower than its 20/20 scenario level and in 2020 the total loss in GDP would reach 0.40%, which means an average loss of 0.05% by year. Both domestic demand and exports are affected by the policy measure. Exports are quite strongly handicapped (-0.98% in 2020) because of the less attractive international perspectives the scenario involves and because of the rising of export prices due to higher production costs (higher energy prices) in Belgium and in partner countries. At the same time, imports get eroded by 1.07%, as the joint consequence of the decrease in energy demand (-1.31%) and the fall in domestic demand (driving less import demand for goods and services). Indeed, other domestic demand variables are also negatively affected by the energy prices raise. Investment is depressed by 0.8% in 2020, owing to a strong negative impact on firm investment (-1.03% in 2020), mainly as the result of the fall in production. The contraction of real household disposable income, mainly due to the rise in consumption prices (larger than the health index rise), brings household consumption down, losing 0.53% in 2020. Notice that the speed of inflation generated by the rise in energy prices slows down after 2017. Simulation results further indicate that the *30/20_flex target scenario* without recycling leads to a drop in employment. Around 23 850 cumulated jobs could be lost in 2020 as the direct result of firms' costs' increase and the slowdown of economic activity. This cut would represent 0.5% of employment with respect to the *20/20 target* scenario. As value added is less affected by the policy shock than employment, productivity per head increases in 2020 (+0.16%). Also, unit labour costs would slightly increase since total wages would go up (because of inflation) and firms' value added decreases. Besides, the higher energy prices and the imported inflation make the share of gross operating surplus in the value added lower by 0.73% in 2020 with respect to its *20/20 target* scenario level.

At the sectoral level, the impact of the energy prices increase (with a no recycling policy) on production and employment is heterogeneous. Production in energy faces the highest fall (2.04% in 2020), directly impacted by a drop in demand. It is followed by the transports and communications sector, which uses much energetic inputs, wherein production decreases by 1.27% in comparison with the *20/20* scenario. In manufacturing industry, production is reduced by 0.61% compared to the 20/20 scenario, a fall especially observed in the sectors of intermediary and consumption goods. For construction, the loss percentage amounts to 0.54% in 2020. Most services suffer much, affected by the loss in real disposable income. The only exception is the health sector wherein the effects are quite limited (-0.05%). Production in the primary sector is cut by 0.63%. Job reductions in percent spread differently among sectors. The most affected sector in 2020 is other market services (-1.03%), followed by trade, hotels, restaurants (-0.76%), two labour-intensive sectors whose production is largely impacted. The employment in the agriculture and construction sectors is also quite much deteriorated, with a loss of 0.59% and 0.53% respectively in comparison with the *20/20 target* scenario. In the transports and communications sector as a whole, in manufacturing and in energy industries, the impact of the policy is less pronounced (-0.37%, -0.26% and -0.11% respectively). Again, health sector records the lowest impact (-0.06%).

Full recycling of new public receipts in reductions of social contributions paid by employers

In this second simulation, both the additional auctioning revenues and the additional carbon tax receipts are recycled in the economy through a reduction of social contributions paid by employers. This simulation should be viewed as a green fiscal reform.

Table 22 gives the impact of this recycling policy on the social contributions paid by the different sectors. Notice that the same rate of reduction was applied *ex ante* to the legal social security contributions rate paid by employers for every sector, i.e. 6.4% in 2020. In 2020, it turns out that the total reduction would reach 2.40 billion €. The amounts of reduction in employers' social security contributions would be the most significant for the other market services, the trade, hotels and restaurants and the health care sectors and the least important for the energy sector.

Table 22: Reduction in employers' social contributions, 30/20_flex target scenario, full recycling policy
in million € (except when mentioned otherwise)

	2013	2017	2020
Energy	-24	-40	-40
Intermediary goods	-119	-191	-192
Equipment goods	-70	-108	-102
Consumption goods	-95	-154	-153
Construction	-87	-152	-160
Transports and communication	-130	-224	-236
Trade, hotels, restaurants, ...	-252	-446	-473
Credit and insurances	-85	-143	-150
Health care	-176	-329	-362
Other market services to households and services	-260	-485	-536
Total	-1299	-2272	-2405
Ex ante % of reduction	-4.7	-6.9	-6.4

Next, we discuss the simulation results of the selected policy, the figures of which are shown in Table 23 (right part).

Under the full recycling assumption, GDP is almost not affected at all by the increase in energy products prices and its loss reaches only 0.13% with respect to the *20/20 target* scenario in 2020. This corresponds to an average annual loss of 0.017%. However, in spite of the positive impact of the recycling policy, all GDP components remain under their *20/20 target* scenario levels on the whole simulation period. Household consumption suffers again the least under this scenario, recording a loss of only 0.22% with respect to the *20/20 target* scenario in 2020. Actually, the decrease in unemployment implied by the labour-encouraging policy cannot offset completely the fall in real disposable income driven mostly by the rise in consumption prices. On the firm side, investment decreases also less than in the no recycling case. The reduction of social contributions paid by employers lowers the production costs but this reduction does not compensate entirely the increase of energy costs and of import prices. Furthermore, as production falls, the overall impact on investment remains negative.

Belgian trade with other countries is less depressed than under the no recycling assumption. In 2020, exports are cut by 0.58% with respect to the *20/20 target* scenario because of the decrease in potential markets. Imports decrease by 0.71%, which is less pronounced than in the no recycling case since domestic demand is not as much affected. As far as the current external balance is concerned, it deteriorates on the whole period, while it was damaged only at the end of the period in the no recycling policy. Finally, the *full recycling policy* generates less inflation (+0.17% only for the deflator of private consumption in 2020) as wages per head are cut, the health index being even slightly lower than in the *20/20 target* scenario in 2020. Employment is obviously stimulated by the reduction in the wage costs per head resulting from the recycling policy in employers' social security contributions. The comparison with the numbers reached in the no recycling case allows to note that around 31 000 cumulated jobs are created in 2020 on account of the reductions in employers' social security contributions, meaning a gain in employment of 7 120 jobs with respect to the *20/20 target* scenario in 2020 (i.e. +0.15%). This upwards move of employment tends to decrease the productivity per head. Unit labour costs now diminish with regard to the *20/20* scenario (they were increasing with the no recycling of tax revenues) as total wages in the firm sector fall more than firms' value added.

The implementation of the *30/20_flex scenario* with full recycling has a negative effect on total production in most sectors. However, the impacts are lower than the ones observed under the no recycling assumption of public revenues. The fall in production is the highest for energy (-1.65% in 2020) and the transports and communication sector (-0.77 in 2020). The remaining sectors are quite moderately affected so that the recycling policy under analysis largely contributes to moderate the negative impact of energy prices' increases on these sectors. Finally, most sectors record a net positive impact with respect to the *20/20 target* scenario from the full recycling policy in terms of employment. The net positive effects are the most important for the manufacturing industries (+0.1% for intermediary goods, +0.5% for equipment goods and +0.5% for consumption goods in 2020 with respect to the *20/20 target* scenario) and construction (+0.56%). For other market services, trade, credit and insurances, as well as health, the gains with respect to the *20/20 target* scenario are less pronounced (between +0.07% and +0.32%). What is more, in two sectors, employment remains slightly lower than in the *20/20* scenario: agriculture (losing 0.17% in 2020) and energy (-0.08% in 2020).

Table 23: Macro-economic results, 30/20_flex target scenario, no recycling policy vs. full recycling policy
% change from 20/20 target scenario

	No recycling of public receipts			Full recycling of public receipts		
	2013	2017	2020	2013	2017	2020
MAIN MACRO-ECONOMIC RESULTS						
Total production	-0.17	-0.74	-0.82	-0.08	-0.4	-0.44
Energy (Final expenditures, in 2000 prices)	-0.08	-1.17	-1.31	-0.05	-1.05	-1.15
Demand components (volumes)						
Households consumption	-0.10	-0.44	-0.53	-0.01	-0.15	-0.22
Investments	-0.15	-0.65	-0.8	-0.09	-0.35	-0.44
of which Firms	-0.20	-0.84	-1.03	-0.13	-0.48	-0.61
Total internal demand	-0.10	-0.40	-0.47	-0.04	-0.17	-0.23
Exports of goods and services	-0.26	-0.90	-0.98	-0.17	-0.54	-0.58
Imports of goods and services	-0.29	-0.94	-1.07	-0.24	-0.63	-0.71
GDP	-0.08	-0.37	-0.40	0.02	-0.11	-0.13
Deflator of private consumption	0.27	0.57	0.42	0.18	0.28	0.17
Health index	0.22	0.42	0.24	0.12	0.11	-0.03

	No recycling of public receipts			Full recycling of public receipts		
	2013	2017	2020	2013	2017	2020
Total employment						
in thousands	-2.05	-17.60	-23.85	4.26	7.82	7.12
in %	-0.05	-0.38	-0.50	0.09	0.17	0.15
Productivity per head (market branches)	-0.03	0.04	0.16	-0.10	-0.33	-0.33
Unit labour cost (Market branches)	0.22	0.33	0.02	-0.65	-0.79	-0.87
Real disposable income	-0.22	-0.49	-0.53	-0.15	-0.26	-0.28
Gross operating surplus of firms (ratio)	-0.26	-0.64	-0.73	0.29	-0.02	-0.18
Current external balance (% of GDP)	0.05	0.02	-0.01	-0.01	-0.06	-0.06
Net lending/borrowing of the public authorities						
Million €-current prices	1009.12	1041.15	878.08	126.74	-78.38	-231.75
% of GDP	0.27	0.24	0.17	0.04	-0.02	-0.06
MAIN SECTORAL RESULTS						
PRODUCTION (volumes)						
Agriculture	-0.31	-0.63	-0.63	-0.17	-0.19	-0.21
Energy	0.11	-1.69	-2.04	-0.17	-1.37	-1.65
Manufacturing industries	-0.25	-0.59	-0.61	-0.10	-0.16	-0.13
Intermediary goods	-0.29	-0.79	-0.77	-0.13	-0.29	-0.18
Equipment goods	-0.21	-0.36	-0.38	-0.10	-0.11	-0.12
Consumption goods	-0.22	-0.51	-0.56	-0.06	-0.06	-0.08
Construction	-0.20	-0.69	-0.54	-0.09	-0.25	-0.19
Transports and communication	-0.31	-1.13	-1.27	-0.22	-0.71	-0.77
Transport by rail	-0.51	-1.77	-1.82	-0.31	-1.00	-1.00
Road transport	-0.35	-1.13	-1.23	-0.23	-0.65	-0.66
Water and air transport	-0.44	-1.55	-1.82	-0.34	-1.06	-1.21
Other transports and communication	-0.27	-1.04	-1.17	-0.19	-0.66	-0.74
Trade, hotels, restaurants, ...	-0.22	-0.79	-0.87	-0.11	-0.37	-0.42
Credit, insurances	-0.18	-0.92	-1.07	-0.10	-0.48	-0.54
Health	-0.01	-0.09	-0.05	0.05	0.00	0.01
Other market services	-0.18	-0.71	-0.81	-0.13	-0.39	-0.45
Total market branches	-0.19	-0.77	-0.84	-0.09	-0.39	-0.42
EMPLOYMENT						
Agriculture	-0.03	-0.29	-0.59	-0.02	-0.09	-0.17
Energy	0.02	-0.10	-0.11	0.02	-0.08	-0.08
Manufacturing industries	-0.05	-0.18	-0.26	0.00	0.20	0.35
Intermediary goods	-0.04	-0.19	-0.29	-0.01	0.06	0.10
Equipment goods	-0.07	-0.18	-0.23	-0.01	0.25	0.50
Consumption goods	-0.05	-0.18	-0.25	0.01	0.29	0.50
Construction	-0.16	-0.62	-0.53	0.37	0.57	0.56
Transports and communication	-0.05	-0.30	-0.37	0.11	0.10	0.05
Transport by rail	-0.11	-0.42	-0.48	0.06	-0.01	-0.01
Road transport	-0.04	-0.32	-0.4	0.07	0.06	-0.01
Water and air transport	-0.04	-0.47	-0.88	0.13	0.33	0.36
Other transports and communication	-0.05	-0.28	-0.33	0.13	0.12	0.07
Trade, hotels, restaurants, ...	-0.05	-0.52	-0.76	0.10	0.17	0.09
Credit, insurances	-0.01	-0.37	-0.65	0.05	0.20	0.19
Health	-0.01	-0.08	-0.06	0.08	0.25	0.32
Other market services	-0.07	-0.77	-1.03	0.17	0.18	0.07
Total market branches	-0.06	-0.46	-0.61	0.12	0.20	0.18

5.1.4. Variant - the 30/20_flex_alt2 target scenario

Both the *20/20 target* scenario and the *30/20_flex target* scenario assume full flexibility in the non-ETS. This assumption translates into an equalized carbon value in the 27 Member countries (5.3 €/t CO_2 and 30.2 €/t CO_2 respectively). The effect of stepping up to -30% was evaluated in this specific context and described in the previous sections (from 5.1.1 to 5.1.3). This section still proposes an evaluation of the effect of stepping up to -30% but in a situation where higher GHG reductions are required domestically (i.e. on the Belgian territory) in the non-ETS.

To do so, an alternative scenario (or variant) has been designed that limits the use of flexibility mechanisms in Belgium in the *30/20_flex target* scenario. In this scenario, called *30/20_flex_alt2 target*, domestic GHG emission reductions in the non-ETS are set equal to -14%[45] in 2020 compared to 2005. This is more than in the *30/20_flex target* scenario (i.e. -11.5%). This scenario is characterized by higher carbon prices in the non-ETS sectors. In 2020, the CV in the non-ETS is evaluated at 50.7 €/t CO_2, against 30.2 €/t CO_2 in the *30/20_flex target* scenario.

Impact on GHG emissions

Table 24 below compares the impact of a stepping up to -30% on GHG emissions when flexibility is fully used in the non-ETS in Belgium (first column) and when this use is limited (second column).

Table 24: GHG emissions in Belgium, 30/20_flex_alt2 target scenario vs. 30/20_ flex target scenarios, year 2020

			30/20_flex target scenario	30/20_flex_alt2 target scenario
Prices	ETS	CV (€/tCO_2)	30.2	30.2
	Non-ETS	CV (€/tCO_2)	30.2	50.7
	RES	RV (€/MWh)	82.0	82.0
Quantities	Total GHG	wrt 2005 (%)	-18.4	-20.3
		wrt 20/20 (%)(*)	-5.1	-6.0
	ETS GHG	wrt 2005 (%)	-27.5	-28.5
		wrt 20/20 (%)(*)	-5.9	-9.9
	Non-ETS GHG	wrt 2005 (%)	-11.5	-14.0
		wrt 20/20 (%)(*)	-4.7	-3.3

Source: PRIMES, NTUA.
wrt = with respect to.
(*): wrt *20/20 target* scenario for column "full flexibility"; wrt *20/20_alt1 target* scenario for column "limited flexibility".

In 2020, the total GHG emission reduction from 2005 level is 2 percentage points lower when higher domestic reductions are required in the non-ETS in Belgium (-20.3% vs. -18.4%). The difference comes mainly from the non-ETS but the GHG emission reduction in the ETS is also affected (-28.5% vs. -27.5%).

45 According to the Decision on the non-ETS, Belgium is allowed to use credits from GHG emission reduction projects in third countries up to a quantity representing 4% of its GHG emissions in the non-ETS in 2005. On top of that it is assumed that half the additional effort (6% = 21% - 15%) can also be met through flexibility outside the EU. By symmetry with the assumption made for the 20/20_alt1 scenario, a domestic reduction effort of 14% in the non-ETS in 2020 (i.e. 21% - 4% - 3% = 14%) is assumed here.

Impact on the energy system

The impact on the Belgian energy system of a stepping up to -30% with further GHG reductions domestically in the non-ETS sector in Belgium (reflected by a higher CV) is summarized below. The impact is first provided in percentage change compared to the *20/20_alt1 target scenario* in 2020 and then compared to the corresponding figures presented in section 5.1.1[46] (figures in brackets):

- Total final energy demand is projected to be 3.3% lower (compared to 2.9%). Final energy consumption drops further in the residential and tertiary sectors. The additional drop concerns essentially gas and electricity;
- Power generation decreases by 4.4% (compared to 2%). The further decrease concerns all energy forms used to generate electricity;
- Gross inland consumption decreases by 3.5% (compared to 2.6%).

Impact on direct cost

Table 25 compares the direct cost of the stepping up to -30% in the two different contexts. In the first case (column "30/20_flex target scenario"), flexibility is fully used by the Member States (i.e. uniform non-ETS carbon value across the EU) for the achievement of their GHG emission targets in the non-ETS[47]. For Belgium, the GHG emission reduction achieved domestically in the non-ETS amounts then to 11.5%. The direct cost is the additional cost compared to the *20/20 target* scenario. In the second case (column "30/20_flex_alt2 target scenario"), the flexibility for the achievement of the non-ETS GHG emission target is limited in Belgium, i.e. the GHG reduction percentage in the non-ETS is set equal to 14%. The direct cost is here the additional cost compared to *20/20_alt1 target* scenario.

Table 25 shows that imposing a limit on the use of flexibility in Belgium for the achievement of the non-ETS target raises the total direct cost of the stepping up to -30% by about 7%. The difference between both cases is of the order of 70 million €'08 in 2020 (balance between an increase in cost related to domestic effort and a decrease in the purchase of flexibility[48]). The increase in cost related to domestic effort comes essentially from the disutility costs.

Table 25: Total direct cost, 30/20_flex_alt2 target scenario vs. 30/20_flex target scenario, year 2020
in million €'08

		30/20_flex target scenario	30/20_flex_alt2 target scenario
Cost related to domestic effort	A	700	800
of which cost related to domestic effort		-850	-1200
Purchase of flexibility in non-ETS	B	190	150
Purchase of flexibility for RES target	C	-60	-50
Total direct cost	A+B+C	830	900

Source: PRIMES, NTUA, own calculations.

N.B. Costs presented in the table are additional costs with respect to the *20/20 target* scenario for the *30/20_flex target* scenario; with respect to the *20/20_alt1 target* scenario for the *30/20_flex_alt2 target* scenario.

Indeed, a higher effort domestically in the non-ETS translates into more savings in energy related expenses: 1.2 billion €'08 in 2020 vs. 850 million €'08 in the *30/20_flex target* scenario.

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46 i.e. when full flexibility is used in the non-ETS in Belgium.

47 For Belgium, the target is assumed to be -21% if there is a stepping up to -30%, against -15% in the current climate-energy legislative package associated to the -20% target at EU level in 2020.

48 In the 30/20_flex_alt2 scenario, the purchase of flexibility in non-ETS is calculated assuming a carbon price of 30 €/t CO_2.

Macroeconomic impact

The macroeconomic impacts of a scenario, wherein, in the context of a move from the 20% EU GHG emission reduction target to a 30% reduction target at EU level, Belgium would strengthen its domestic GHG emission reduction in the non-ETS, will be presented briefly in what follows. The results are given in comparison with the levels of the *20/20_alt1 target* scenario[49], except when mentioned otherwise.

Actually, the carbon values increases from their *20/20_alt1 target* scenario levels result in an *ex-ante* impact on average energy prices of about 5.1% in 2020. This effect is in fact lower than the one reached in the *30/20_flex target* scenario in the first half of the period under consideration but higher when approaching 2020[50].

The new public receipts[51] collected through the implementation of this particular emissions' reduction scenario remain lower than in the *30/20_flex* scenario on the whole simulation period. This can be explained by a similar increase in the carbon value of the ETS sector, but a smaller one in the non-ETS part. However, in 2020, the new receipts are only a tiny bit lower than those perceived in the main scenario and amount to 2.3 billion € (0.46% of GDP). The same rate of reduction was applied *ex ante* in every sector to the legal social security contributions rate paid by employers, i.e. 6.2% in 2020.

Table 26: Ex ante impacts of carbon values on energy prices and additional public receipts, 30/20_flex_alt2 target scenario

	2013	2017	2020
Average energy price (% change from 20/20_alt1)	1.1	3.3	5.1
Of which households	1.1	3.5	5.5
Total new public receipts (difference with 20/20_alt1 in bn €)	0.51	1.44	2.33
In % of GDP	0.13	0.32	0.46

Since the variant concerns only Belgium, it was assumed that the international environment was modified in the same way as in the *30/20_flex* target scenario (see Table 21 for the change of the potential export market, export prices and import prices for Belgium).

No recycling of new public receipts

The main macroeconomic impacts of the *30/20_flex_alt2 target* scenario with no recycling of public receipts are presented in Table 27 below (left part).

Generally speaking, at the end of the simulation period, the main macroeconomic results of the *30/20_flex_alt2 target* scenario with no recycling of public receipts are very close to the ones found in the main scenario without recycling (*30/20_flex target* scenario with no recycling, described in section 5.1.3.). It would imply a loss of 0.39% of GDP with respect to the *20/20_alt1 target* scenario in 2020. Once more, exports and imports are badly impacted with a loss of 0.97% and 1.02% respectively in compar-

49 For recall, the *20/20_alt1 target* scenario assumes that, in a context of a 20% EU GHG reduction and 20% EU RES development by 2020, Belgium achieves more reductions internally in the non-ETS sector, namely 11%.

50 The explanation of this particular energy prices evolution is to be found in the electricity prices differential given by PRIMES.

51 The new public receipts are again computed as the additional public receipts generated by the moving from the variant for Belgium of 20% EU GHG reduction target scenario (*20/20_alt1*) to the variant for Belgium of the 30% EU GHG reduction target (*30/20_flex_alt2*) in 2020.

ison with the *20/20_alt1 scenario* in 2020. While exports face the same impact as in the *30/20_flex target* scenario (with no recycling), imports are increased when compared to it at the end of the period since Belgium, intensifying its emission reduction effort, deteriorates its price competitiveness. On the domestic demand side, household consumption is decreased by 0.45% compared to the *20/20_alt1* scenario at the end of the period. This loss is somewhat weaker than in the *30/20_flex scenario* (with no recycling), since the real disposable income is slightly less cut. Indeed, although the consumption price ends up at a somewhat higher level than in the *30/20_flex scenario* (with no recycling), the real disposable income suffers less because of the employment evolution (see below). Investments are again badly affected by increasing production costs (-0.96% for firm's investment with respect to the *20/20_alt1* scenario in 2020). About 21 190 cumulated jobs could be lost in 2020 as the direct result of firms' costs increase and the slowdown of economic activity. This is a little less than in the main simulation exercise.

As far as the sectoral impacts on production and employment are concerned, the most badly affected sectors (energy and transports and communication sectors as far as production is concerned; other market services, trade, hotels and restaurants as far as employment is concerned) are the same as in the *30/20_flex scenario* (with no recycling). In the same way, the least badly affected sector (i.e. the health as far as both production and employment are concerned) is also the one found in the *30/20_flex scenario* (with no recycling).

Full recycling of new public receipts in reductions of social contributions paid by employers

The main macroeconomic impacts of the *30/20_flex_alt2* scenario with full recycling of public receipts are presented in Table 27 below (right part).

The *30/20_flex_alt2* scenario with recycling would again imply similar results to those of the main simulation in terms of activity at the end of the simulation period. Actually, it would lead to a tiny loss of 0.13% of GDP with respect to the *20/20_alt1* scenario in 2020. Although GDP's components benefit considerably directly or indirectly from the recycling policy, they all remain negatively affected with respect to the *20/20_alt1* scenario in 2020. Exports and imports are the most impacted GDP's components with a loss of 0.57% and 0.67% respectively in comparison with the *20/20_alt1* in 2020. Regarding domestic demand, household consumption is decreased by 0.17% in comparison with the *20/20_alt1* at the end of the period. Investment suffers again from production costs which remain on average higher than in the *20/20_alt1* scenario in spite of the reduction in employers' social contributions (-0.58% for firm's investment compared to the *20/20_alt1* in 2020). About 3 890 cumulated jobs could be added to those of the *20/20_alt1* scenario in 2020 as the positive effect of the cut in labour price. This represents a narrower net impact than in the main scenario, due to the smaller amounts of recycled public receipts during the first years of the simulation.

As far as the sectoral impacts are concerned, the sectors whose production remains the most badly affected (energy and transports and communication) or whose employment remains under the *20/20_alt1* scenario in spite of the recycling (agriculture and energy) are the same as in the *30/20_flex scenario* (with recycling). In the same way, the least badly affected or even benefiting sectors in terms of production (health and consumption goods) or the most benefiting sectors in terms of employment (construction, consumption goods and equipment goods) are also those found in the *30/20_flex scenario* (with recycling).

Table 27: Macro-economic results, 30/20_flex_alt2 target scenario, no recycling policy vs. full recycling policy
% change from 20/20_alt1

	No recycling of public receipts			Full recycling of public receipts		
	2013	2017	2020	2013	2017	2020
MAIN MACRO-ECONOMIC RESULTS						
Total production	-0.13	-0.56	-0.79	-0.09	-0.33	-0.43
Energy (Final expenditures, in 2000 prices)	-0.25	-0.87	-1.41	-0.24	-0.80	-1.28
Demand components (volumes)						
Households consumption	-0.04	-0.27	-0.45	-0.01	-0.10	-0.17
Investments	-0.09	-0.48	-0.74	-0.07	-0.29	-0.42
of which Firms	-0.12	-0.64	-0.96	-0.10	-0.41	-0.58
Total internal demand	-0.06	-0.27	-0.42	-0.03	-0.13	-0.20
Exports of goods and services	-0.22	-0.81	-0.97	-0.16	-0.51	-0.57
Imports of goods and services	-0.21	-0.79	-1.02	-0.17	-0.53	-0.67
GDP	-0.07	-0.30	-0.39	-0.03	-0.12	-0.13
Deflator of private consumption	0.11	0.38	0.49	0.07	0.18	0.25
Health index	0.11	0.32	0.35	0.07	0.12	0.10
Total employment						
in thousands	-1.40	-12.66	-21.19	1.09	1.48	3.89
in %	-0.03	-0.27	-0.44	0.02	0.03	0.08
Productivity per head (market branches)	-0.04	-0.01	0.10	-0.06	-0.18	-0.24
Unit labour cost (Market branches)	0.13	0.28	0.18	-0.21	-0.50	-0.80
Real disposable income	-0.09	-0.33	-0.50	-0.06	-0.18	-0.28
Gross operating surplus of firms (ratio)	-0.13	-0.46	-0.71	0.09	-0.01	-0.10

5.2. The 30/20 target scenario without flexibility (30/20_int)

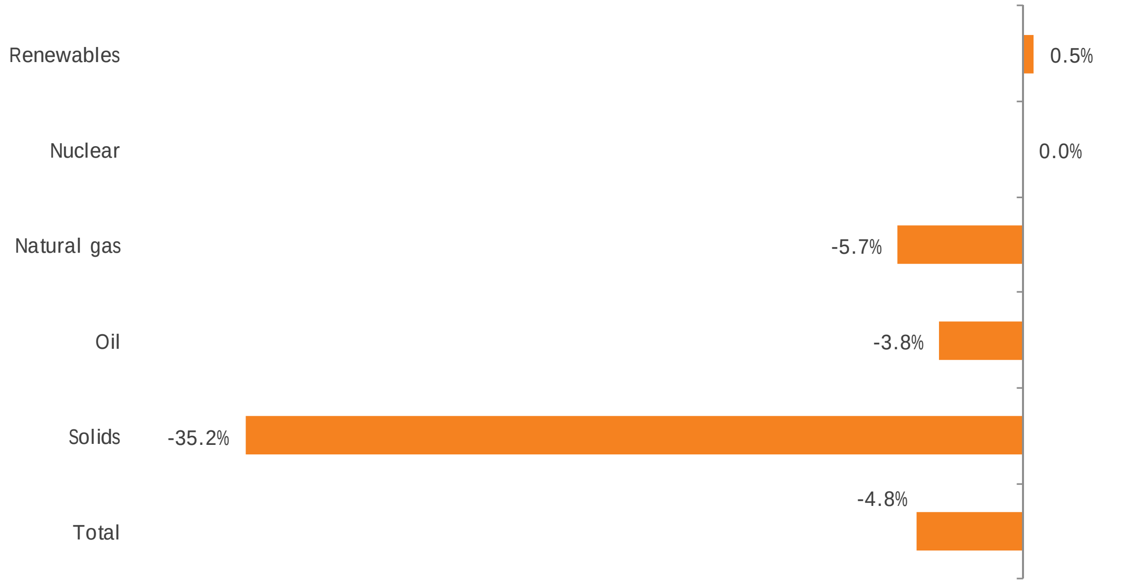
5.2.1. Impacts on the energy system

As in the section devoted to the *30/20_flex target* scenario, graphs and analyses will be made with respect to the *20/20 target* scenario and focus lies on the year 2020.

Gross Inland Consumption

A first impact studied is the effect the carbon and renewable values of the *30/20_int target* scenario have on Gross Inland Consumption (GIC). One direct consequence of the stepping up to -30% is the decrease in GIC by 4.8% in 2020 compared to the *20/20 target* scenario. This effect concerns all fossil fuels whereas RES consumption remains basically at the same level as in the *20/20 target* scenario. Solid fuels support the largest dip, their consumption being cut by 35%. The other fossil fuels also see their demand shrivelled: by some 4% for oil and 6% for natural gas.

Figure 28: Gross Inland Consumption, 30/20_int target scenario, year 2020
% change compared to the 20/20 target scenario



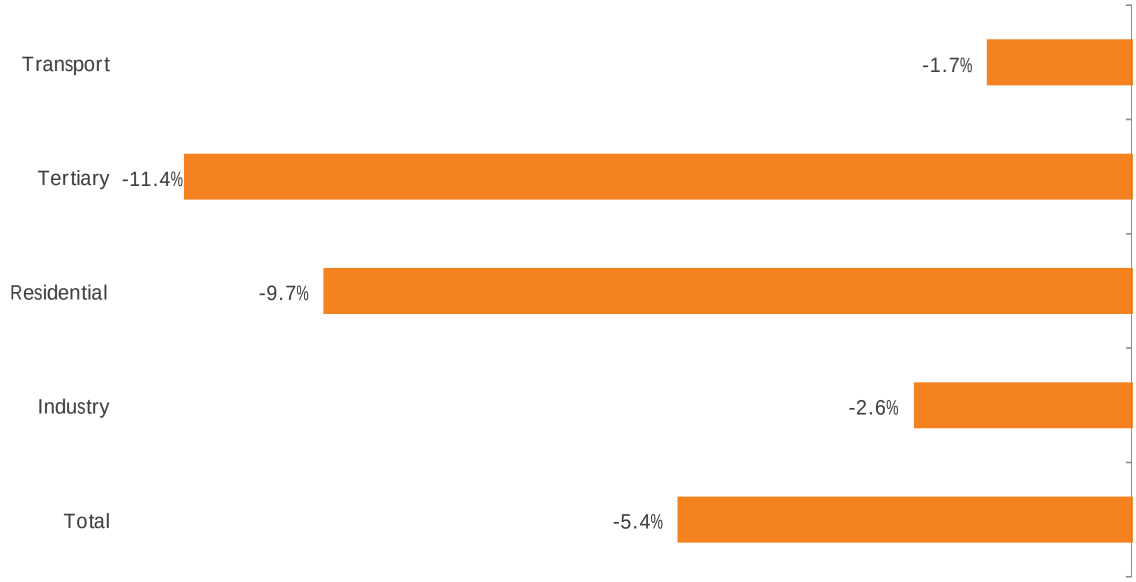
Source: PRIMES.

As expected, both GIC and imports of fossil fuels (Belgium has no fossil fuel resources) decrease more significantly with respect to the *20/20 target* scenario when the stepping up to -30% is fully implemented domestically (i.e. on the EU territory or, in other words, without flexibility). For instance, GIC would drop by about 5% in the *30/20_int target* scenario against some 3% in the *30/20_flex target* scenario.

Final Energy Demand

The final energy demand is also affected: it is cut by over 5%. Tertiary and the residential sector bear the largest effect of the stepping up of the GHG target. The final energy consumption of these sectors is reduced by 10 to 11% in 2020 compared to the *20/20 target* scenario. The decrease in final energy demand in industry and transport is comparatively smaller (-3 and -2% respectively). Translating these percentages into absolute numbers, we see that energy savings in the residential sector are the biggest (around 1 000 ktoe), tertiary follows by economising 600 ktoe, whereas transport and industry cut down by approximately 200 and 350 ktoe respectively.

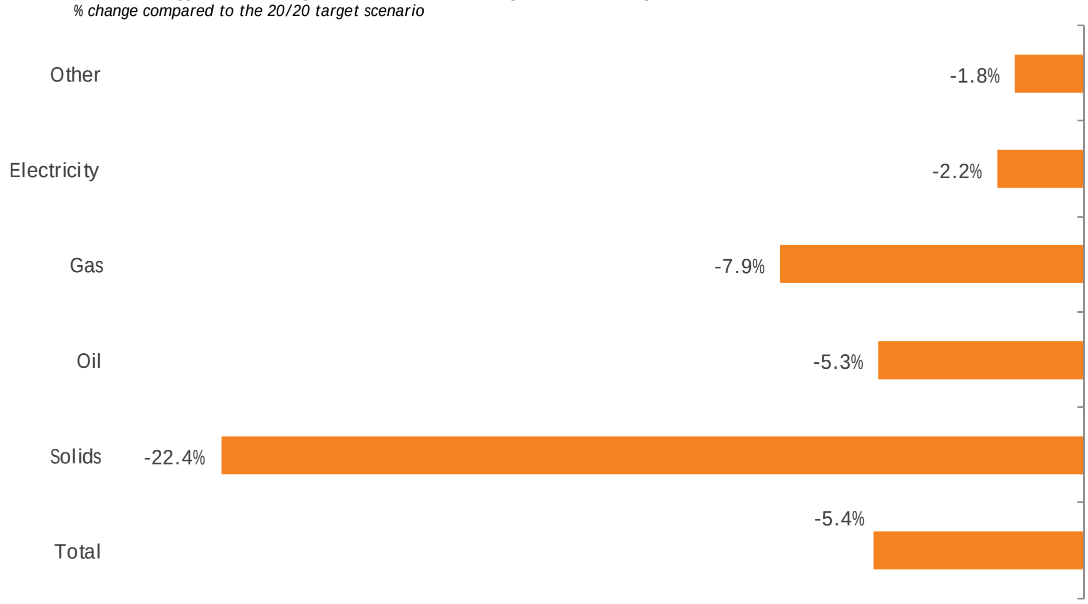
Figure 29: Final Energy Demand by sector, 30/20_int target scenario, year 2020
% change compared to the 20/20 target scenario



Source: PRIMES.
NB: Transport does include aviation.

Looking now at the impact on the energy mix of the final energy demand, we see that all energy forms are cut back. Solids in particular see their consumption diminished by more than one fifth. This is due to the higher carbon value (55.4 €/t CO_2 in 2020 against 16.5 €/t CO_2[52] in the *20/20 target* scenario) that affects coal more than oil and gas because it has the highest carbon content. The consumption of electricity, heat and renewable energy sources decreases also but to a lesser extent, by more or less 2%.

Figure 30: Final Energy Demand by fuel, 30/20_int target scenario, year 2020
% change compared to the 20/20 target scenario



Source: PRIMES.
NB: "Other" stands for renewable energy and heat.

52 This is the carbon value in the ETS sector as coal is mainly used in the iron and steel sector which belongs to the ETS.

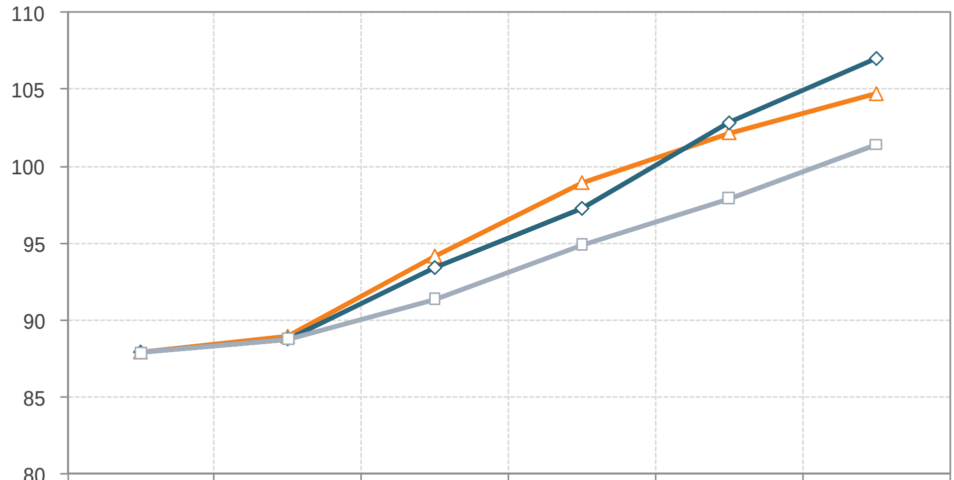
Power generation

Power generation is closely related to the demand for electricity[53]. Interesting observation (see Figure 31) is that electricity demand, although increasing, stays under the *baseline* level for the entire period of projection. In contrast to the *20/20 target* scenario, electricity demand thus never recovers to surmount the *baseline* level. It finally arrives, in 2030, at a level that is 3% (resp. 5%) lower than *baseline* (resp. *20/20 target* scenario). Explanation has to be sought in the fact that the cost for power generation is higher in the *30/20_int target* scenario, due to a triple effect: (1) an electricity production based on even more renewable energy sources beyond 2020 (31% of net electricity generation in 2030 against 24% in *baseline* and 28% in the *20/20 target* scenario), (2) the development of CCS from 2020 onwards pushed by the CV and (3) increased price of emission quotas to be purchased due to a significantly higher CV in the ETS sectors (55 and 62 €/tCO_2 in 2020 and 2030 respectively against 25 and 39 €/tCO_2 in *baseline* and 16.5 and 19 €/tCO_2 in the *20/20 target* scenario).

The evolution pattern of electricity demand and power production in the *30/20_int target* scenario is very similar to that in the *30/20_flex target* scenario. All in all, called-up power increases every year by 0.6% on average between 2005 and 2030.

Figure 31: Called-up electrical power, baseline, 20/20 target and 30/20_int target scenarios, evolution, 2005-2030

TWh



	2005	2010	2015	2020	2025	2030
Baseline	88	89	94	99	102	105
20/20 target	88	89	93	97	103	107
30/20_int target	88	89	91	95	98	101

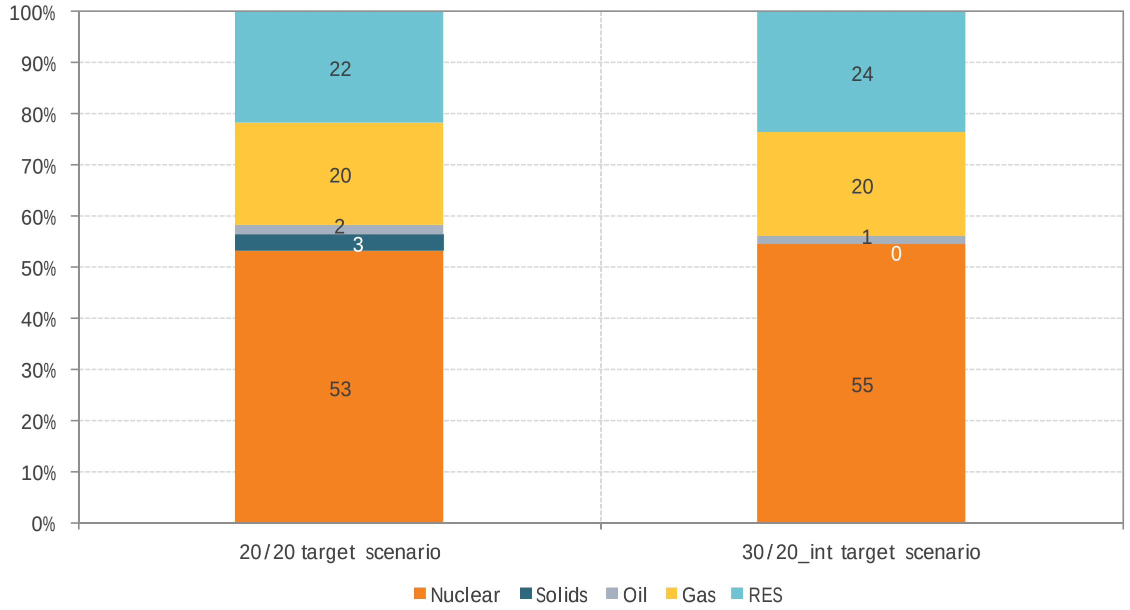
Source: PRIMES, own calculations.

N.B. 2010 figures are projections, not statistics.

53 This is so because imports of electricity are exogenously fixed and do not change according to the scenario.

Figure 32: Net electricity generation, 30/20_int target scenario vs. 20/20 target scenario, year 2020

%



Source: PRIMES.

In total, 83.8 TWh of electricity are produced in 2020 (compared to 86.2 TWh in the *20/20 target* scenario). The figure refers to net power production. The fuel mix is comparable to that in the *20/20 target* scenario, although differing from the latter on the total lack of solids and a slightly higher percentage of renewables and nuclear energy (+ 2 percentage points in both cases).

To wrap up the situation in the power sector, Table 28 shows a selection of sector specific parameters for the *30/20_int* target scenario, next to the ones in the *20/20 target* scenario.

Table 28: Indicators related to the power generation sector, 30/20 target_int scenario vs. 20/20 target scenario, year 2005 and 2020

	2005	2020 20/20 target	2020 30/20_int target
Efficiency for net thermal electricity production (%)	40.5	41.2	42.6
Net imports ratio (%)	6.9	11.4	11.7
% net electricity from CHP	9.0	16.3	19.6
% electricity from RES	4.1	21.6	23.5
Share of non-fossil fuels in net power generation (%)	59.1	74.7	78.2
Net installed power capacity (GW)	14.7	20.7	20.9
Carbon intensity (tCO_2/GWh)	230	111	80
Electricity (final demand) per capita (kWh/capita)	7675	7889	7712

Source: PRIMES.

The evolution of the average efficiency of thermal electricity production is closely related to the technology mix. The figure reported for the year 2020 in the *30/20_int target* scenario is higher than in 2005 (+2.1 percentage points) and also than the figure quoted for 2020 in the *20/20 target* scenario (+1.4 percentage points). This is mainly due to the fact that more gas and less coal are used[54] in the former scenario.

[54] Gas (especially combined cycle gas turbines or CCGTs) is characterized by higher conversion efficiency (close to 60% for new generation) than coal (around 50% for supercritical coal power plants).

The level of net imports is exogenously fixed and does not change according to the scenario. The net imports ratio (i.e. the ratio between net imports and total electricity supply) increases over time because of higher net imports in both scenarios.

The share of non-fossil fuels in electricity production combines two elements: nuclear on the one hand, renewable energy sources on the other. As the entire nuclear power park, representing about half of total Belgian electricity production in 2005, stays available through 2020 further to the delay in decommissioning, the share of nuclear energy stays quasi unchanged throughout the 2005-2020 period. By contract, the share of renewable energy sources keeps on climbing: representing only 4% in 2005, it reaches almost 24% by 2020 in the *30/20_int target* scenario, against 21.6% in the *20/20 target* scenario.

The share of CHP (covering both fossil fuels and biomass based cogeneration) in electricity generation steadily goes up: from 9% in 2005, it reaches close to 20% in 2020 in the *30/20_int target* scenario compared to 16% in the *20/20 target* scenario.

The installed power capacity increases by 42% over the period 2005-2020 in the *30/20_int target* scenario; this is slightly more than in the *20/20 target* scenario (40%). Power capacity increases at a higher pace than electricity demand. Reason has to be searched in the decrease in average utilisation rate of electrical capacities: in 2005, it was around 64%; in 2020, it is estimated to be 46% in the *30/20_int target* scenario[55].

The table below depicts RES-based net power generation and capacity in the *30/20_int target* scenario in the year 2020, as well as the percentage of change compared to the *20/20 target* scenario for the same year. Hydro and solar PV do not change (hardly) with respect to the *20/20 target* scenario, whereas wind and biomass and waste grow further when the stepping up to -30% is achieved in the EU without any further flexibility. Biomass and waste increase their power capacity by 1% and their power production by 6%. Offshore wind contributes to the wind accumulation; the offshore installed capacity becomes 2 200 MW compared to 2000 MW in the *20/20 target* scenario. Wind is accountable for the largest part (56%) of RES based electricity production in 2020 (11 TWh).

Table 29: RES net power capacity and net electricity generation in the 30/20 target_int scenario, year 2020

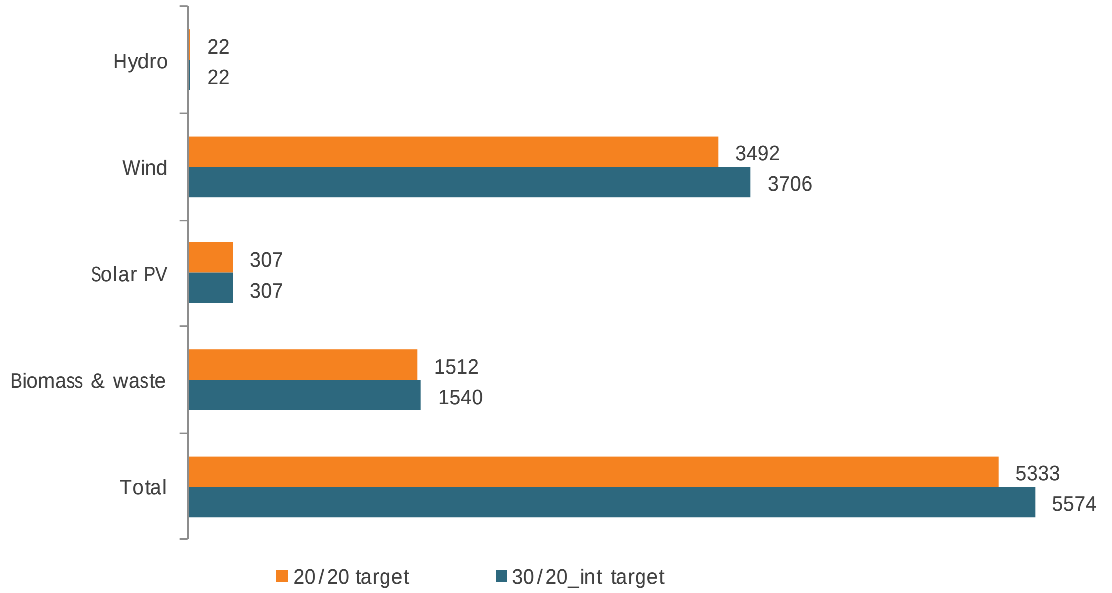
	Net power capacity (MW)		Net electricity generation (GWh)	
	2020	% change compared to 20/20 target	2020	% change compared to 20/20 target
Hydro	138	0%	404	0%
Wind	3873	6%	11052	7%
Biomass and waste	2095	1%	7975	6%
Solar PV	309	0%	299	0%
Total	6415	4%	19730	6%

Source: PRIMES, own calculations.

Figure 33 shows the additional net installed RES power capacity for the *20/20* and the *30/20_int target* scenarios. We see that the stepping up to -30% only affects the development of offshore wind capacity, when flexibility is not allowed for meeting the GHG target.

[55] The decrease in average utilisation rate (i.e. generation/(installed capacity x 8 760 hours)) is due to the higher share of power capacities based on intermittent energy sources such as wind and solar.

Figure 33: Net installed RES power capacity, 20/20 and 30/20_int target scenarios, year 2020: difference from 2005
MW



Source: PRIMES.

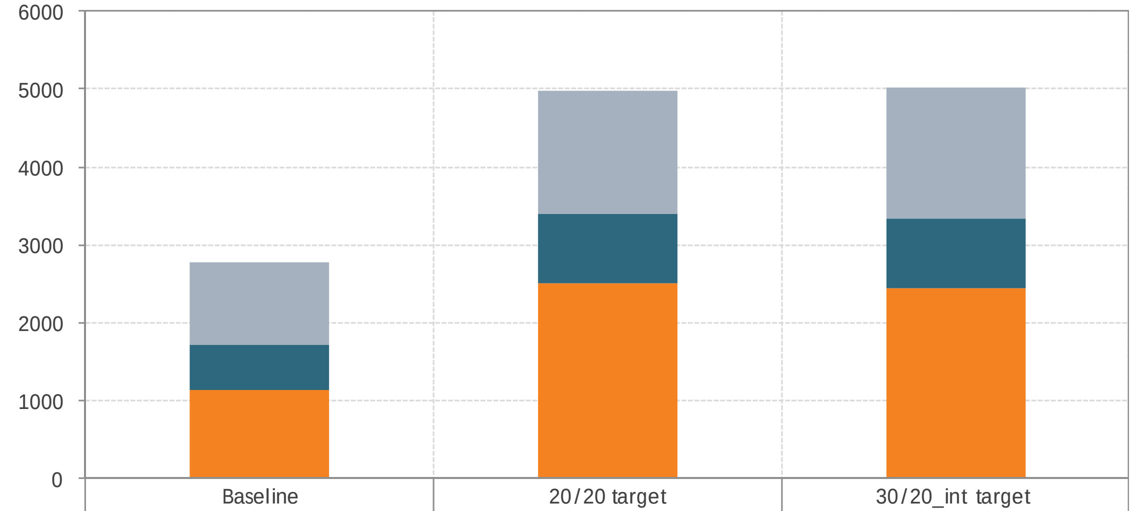
RES in Gross Final Energy Demand

After this overview of renewable energy forms within the power sector in the *30/20_int target* scenario, we look at the share of RES in Gross Final Energy Demand. In Belgium, a 13% share in Gross FED should be reached by 2020 according to RES Directive 2009/28/EC. In the *20/20 target* scenario, we saw that a 12.5% share or some 4 900 ktoe (approx. 58 TWh) is obtained in 2020 with a renewable value of 82 €/MWh. The *30/20_int target* scenario, with the same RV, steps up this effort and reaches 13.2%. The increase is mainly due to the lower level of final energy demand (denominator). RES consumption (numerator) increases only marginally compared to the *20/20 target* scenario. Figure 34 splits up the RES consumption into the different uses (heating and cooling[56], transport and electricity, or RES-H, RES-T and RES-E).

[56] As it does not seem trivial to estimate the amount of renewable energy consumed by heat pumps (due to an apparent absence of threshold, the lack of data on the existing stock of heat pumps and their average coefficient of performance), the contribution of heat pumps to RES-H is not taken into account. This causes a (slight) underestimation of (the percentage of) RES-H.

Figure 34: Renewables in Gross Final Energy Demand, baseline, 20/20 target and 30/20_int target scenarios, year 2020

ktoe



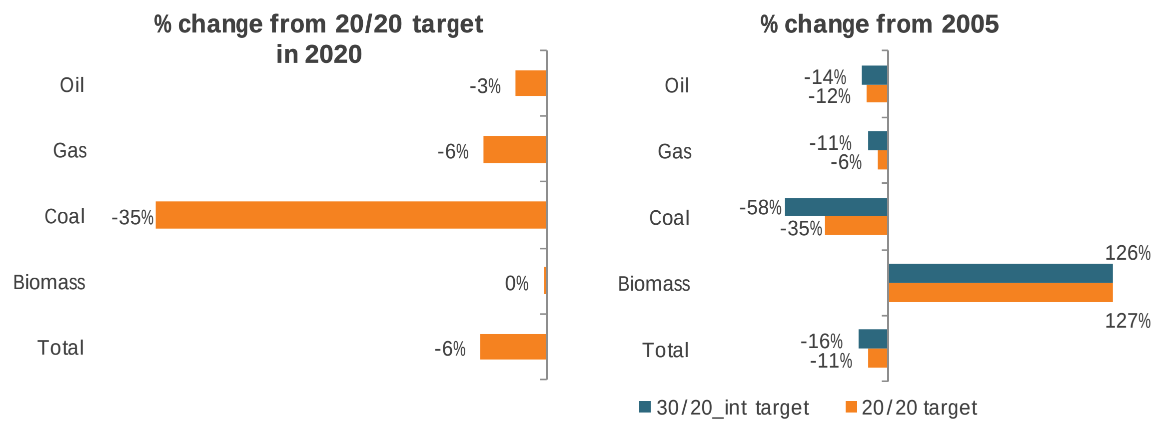
	Baseline	20/20 target	30/20_int target
RES-E	1056	1576	1679
RES-T	585	900	892
RES-H	1130	2505	2443

Source: PRIMES.
NB: RES-H encompasses at the same time the heat produced in biomass-based CHP as the biomass' and solar heat used for space and water heating.

Import dependency

The results of the *30/20_int target* scenario show that the stepping up to -30% improves the security of our energy supply through the decrease in fossil fuel imports. Total energy imports drop by 6% from the *20/20 target* scenario level in 2020. Moreover, achieving the 30% GHG reduction target fully internally (i.e. in the EU) allows reducing further energy imports. Relative to the year 2005, total energy imports are projected to be 16% lower in 2020, whilst the decline amounts to 11% in the *20/20 target* scenario and to 14% in the *30/20_flex target* scenario.

Figure 35: Changes in net energy imports of Belgium, 30/20 target_int scenario, year 2020



Source: PRIMES.

The changes in the Belgian energy system which characterize the *30/20_int target* scenario bring about that the effect on energy demand prevails against substitution effects among fossil fuels. Imports of all fossil fuels decrease compared to the *20/20 target* scenario. The extent of the decline depends, however, on the type of fossil fuel. Coal drops by 35% compared to the *20/20 target* scenario level in 2020, mainly due to its complete disappearance in the power generation sector. The decline amounts to 6% for natural gas and to 3% for oil. It is mainly due to energy efficiency improvements in the tertiary and domestic sectors. On the other hand, the stepping up to -30% has almost no impact on biomass imports.

In monetary terms, the reduction in oil, gas and coal imports translates into a saving of about 0.9 billion € in 2020 compared to the *20/20 target* scenario (in € of 2008); when we only consider the decline in oil and gas imports, 0.7 billion € can be economised.

5.2.2. Impact on GHG emissions

The GHG emissions add up to 105.9 Mt of CO_2 equivalent in Belgium in 2020, i.e. some 9% down from the level in the *20/20 target* scenario emissions (116.8Mt). The emission level in the *30/20_int target* scenario corresponds to a 22% reduction of GHG emissions from 2005 level, instead of a decrease by 14% as projected under the *20/20 target* scenario.

Table 30: GHG emissions in Belgium, 30/20_int target scenario

	2020 (Mt CO_2 eq.)	2020 change from 20/20 target (%)	2020 vs. 2005 'domestic reduction' (%)	2020 vs. 2005 'assumed target' (%)
All GHGs	105.9	-9.4	-22.0	-
All CO_2	91.0	-9.3	-22.6	
ETS sectors	39.5	-12.2	-32.4	-
ETS without aviation	35.1	-13.1	-35.7	
Aviation	4.4	-4.9	15.3	
Non-ETS sectors	66.4	-7.6	-14.3	-21%(*)
Energy related CO_2	51.5	-6.9	-12.9	
Non-CO_2 GHGs	14.9	-9.9	-18.6	

Source: PRIMES, GAINS, NTUA.

NB: The allocation of total GHG emissions between ETS and non-ETS is made according to scope '08-12'. The model based emission data differ from the emissions officially reported to the UNFCCC. However, the former are coherent with the model results to 2020 which therefore allow getting insight into the energy-climate policy of Belgium.

(*): The figure of -21% is arbitrary. It is not a suggestion for an updated reduction target in the non-ETS.

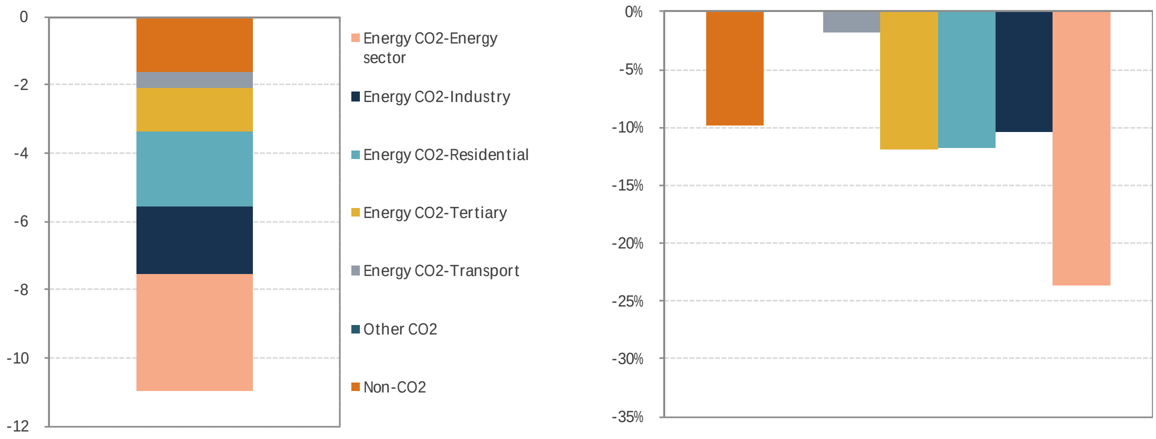
In 2020, CO_2 emissions are projected to be about 23% lower than the level of 2005. This evolution corresponds to a further decrease by 9% compared to the emissions in the *20/20 target* scenario. The emissions of non-CO_2 GHGs are projected to plunge by nearly 19% in 2020 compared to 2005.

In the ETS sector, which experiences a carbon price of 55 €/tCO_2 in 2020, GHG emissions decline by 32% from 2005 in 2020. The non-ETS sector, having a similar carbon price, depicts a lower reduction percentage: in 2020, GHG emissions are reduced by 14% compared to 2005. It is worth to underline that the emission trend in the ETS sector in Belgium is part of the European target.

Table 30 only relates to emission reductions realized domestically. Flexibility within the EU, both in the ETS and the non-ETS sectors allows Belgium to achieve further GHG emission reductions. In the non-ETS sector, no specific target is (yet) proposed if the EU moves to a 30% GHG emission reduction target in 2020, as opposed to the -15% target Belgium got assigned in the legislative Climate-Energy Package of June 2009.

Finally, Figure 36 shows how the emission reduction effort realized domestically is allocated among the sectors (for energy related CO_2 emissions) and among the different categories of GHGs.

Figure 36: GHG emission reductions, 30/20_int target scenario, year 2020: difference from 20/20 target scenario
Mt CO_2 eq. (left) and % (right)



Source: PRIMES, GAINS.
NB: Transport includes international aviation; energy sector encompasses the power sector and other energy transformation sectors.

As in the *30/20_int target* scenario, the major contributor to further GHG emission reductions in Belgium, both in absolute and relative terms, is the energy sector where the major part of the reduction takes place in the power sector and relates to CO_2 emissions. In relative terms, CO_2 emission reductions in industry, the residential and tertiary sectors and non-CO_2 emission reductions are comparable (from 10 to 12% compared to the *20/20 target* scenario). In transport, CO_2 emission reductions are comparatively less significant (-2%).

5.2.3. Economic cost

As in the analysis of the *30/20_flex target* scenario, the evaluation of the economic cost for Belgium of stepping up to -30% fully internally (i.e. in the EU) involves two complementary approaches. The first approach relies on the assessment of the direct cost (section 0) which encompasses two components: (1) the direct (energy) cost related to domestic effort evaluated with PRIMES and (2) the cost related to flexibility. The second approach deals with the macroeconomic impact of moving towards a 30% GHG reduction target at EU level; it relies on the HERMES model.

Direct cost

Direct (energy) cost related to domestic reduction

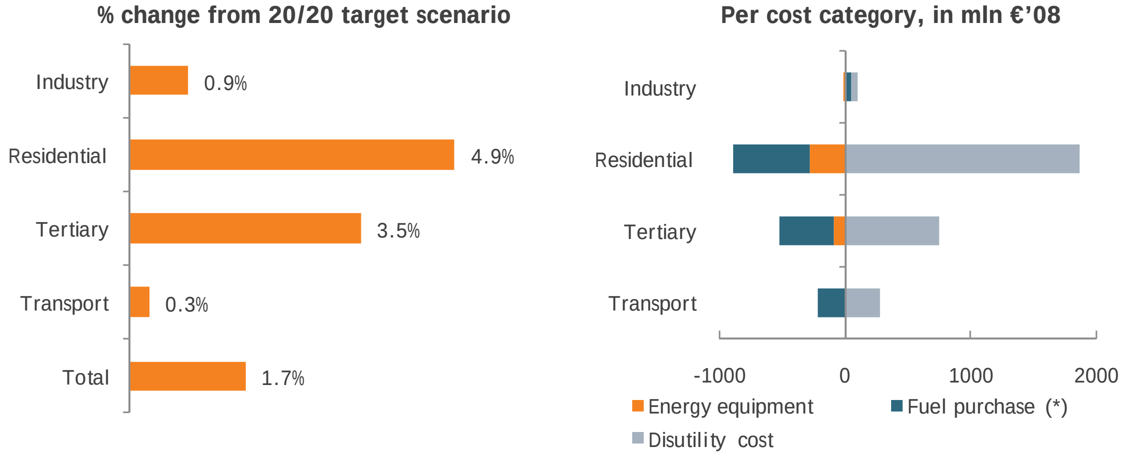
This section describes the direct energy cost of achieving the domestic GHG emission reductions and the domestic RES production defined in the *30/20_int target* scenario. This cost encompasses the additional costs, compared to the *20/20 target* scenario, experienced by Belgian energy users related to the domestic mitigation and renewable energy production efforts as a result of the carbon prices and RES value.

The direct energy cost includes the annual payment of investments in RES and energy efficient technologies, the costs related to thermal integrity improvements and rational use of energy not explicitly modelled by technologies as well as stranded costs (when e.g. energy equipments are prematurely replaced), the changes in operation and fuel costs and the costs related to losses of utility for energy services. The latter cost category is also referred to as disutility costs, e.g. the costs of actions to remove barriers to energy efficiency improvement or to adapt energy consumption behaviour.

The direct energy cost does, however, not include the cost resulting from mitigation measures for the non-CO_2 GHG and the costs related to flexibility in the non-ETS, on the one hand, and for achieving the RES target, on the other hand.

In 2020, the direct energy cost increases by 1.3 billion €'08 (or by 2.3%) in the *30/20_int target* scenario compared to the *20/20 target* scenario. This amount represents 0.33% of Belgium's projected GDP in 2020. Figure 37 shows cost changes in each final demand sector and how the extra cost is allocated among the three cost categories.

Figure 37: Direct energy cost, 30/20_int target scenario, year 2020



Source: PRIMES, NTUA.
(*) Fuel purchase costs relate to all energy sources (fossil, electricity, steam, RES).

In 2020, the additional domestic effort implemented in the *30/20_int target* scenario translates into a direct energy cost increase by 5% in the residential sector, by approximately 4% in the tertiary sector and by less than 1% in transport and industry. These evolutions take into account the changes in costs in the power and heat sector.

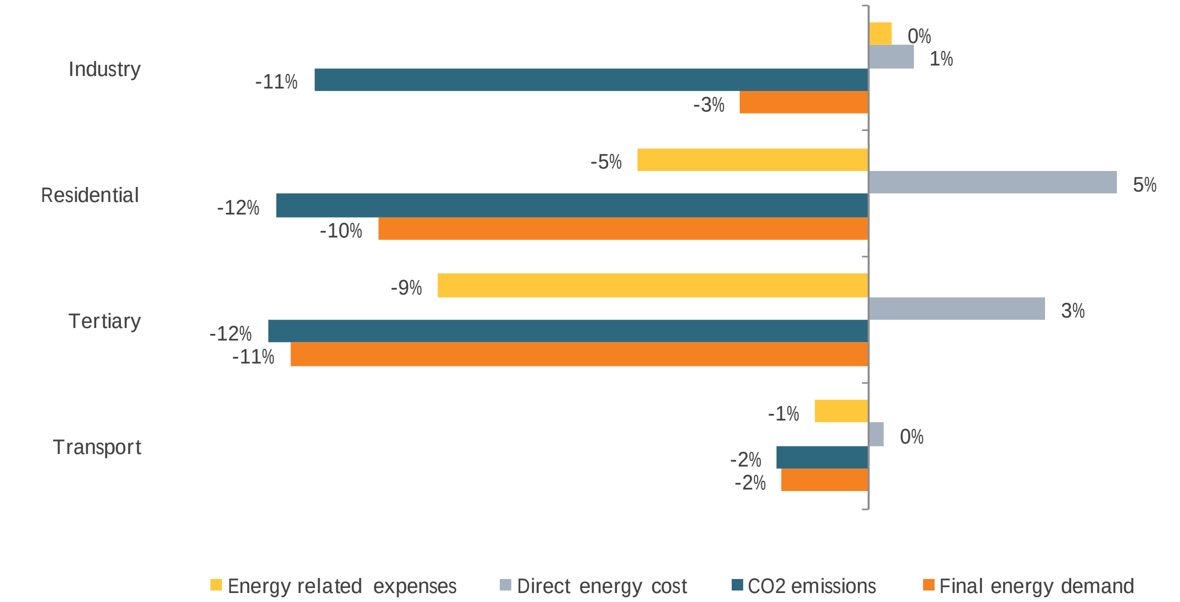
The additional cost results from a significant increase in disutility costs whereas fuel and equipment costs drop compared to the *20/20 target* scenario. Disutility costs climb particularly strongly in the residential sector, followed by the tertiary sector and transport. Fuel purchase costs decrease in all final demand sectors except in industry though moderately. In the latter case, fuel purchase costs go up because fuel switching and energy savings are not high enough to compensate for fuel cost increases (due to the CV)[57]. Finally, the stepping up to -30% has only a minor impact on equipment costs.

The following figure goes one step further. It puts into perspective the relationship between direct energy costs and decreases in CO_2 emissions and energy consumption compared to the *20/20 target* scenario. The difference between direct energy costs and energy related expenses is the disutility cost.

[57] The decrease in final energy demand is about 3% in industry while it is in the range of 11 to 12% in the residential and tertiary sectors (see section 0).

Although the disutility cost is a real cost supported by the economic agents or the economy as a whole, it is not, strictly speaking, a spending of the energy consumers. Energy related expenses therefore only encompass energy equipment and fuel costs.

Figure 38: Sectoral indicators, 30/20_int target scenario, year 2020
% change compared to 20/20 target scenario



Source: PRIMES, NTUA.

Figure 38 shows that the *30/20_int target* scenario goes hand in hand with a further decrease in final energy demand, especially in the residential and tertiary sectors, which translates afterwards into a drop of energy related expenses. CO_2 emissions in the residential and tertiary sectors decrease by 12% in 2020 compared to the *20/20 target* scenario. The effect is less marked for transport (-2%). As far as industry is concerned, the figure shows that the impact of fuel substitution is higher than the impact of energy savings: CO_2 emissions are reduced by 11% while energy consumption is (only) reduced by 3%. To summarize, results show that energy saving is the main answer of the residential and tertiary sectors to the strengthening of the GHG emission target, whereas fuel switching is preferred in industry.

Total direct cost

The total direct cost is the sum of the direct cost related to domestic effort and costs related to flexibility. The latter involves the purchase of flexibility in the non-ETS well as to meet the RES target. Table 31 presents the estimation of the direct cost including flexibility of the *30/20_int target* scenario in 2020, i.e. the additional cost compared to the *20/20 target* scenario.

Table 31: Total direct cost, 30/20_int target scenario, year 2020
compared to the 20/20 target scenario

		In % of GDP	In million € '08
Cost related to domestic effort	A	0.33	1340
Of which energy related expenses		*-0.39*	*-1600*
Purchase of flexibility in non-ETS	B	0.03	120
Purchase of flexibility for RES target	C	-0.04	-160
Total direct cost	A+B+C	0.32	1300

Source: PRIMES, NTUA, own calculations.
N.B. Costs presented in the table are additional costs with respect to the *20/20 target* scenario.

The cost related to domestic effort encompasses the direct energy cost and the cost resulting from mitigation measures for non-CO_2 GHG. This latter cost category was not estimated in this study (see section 4.4.2).

In the *30/20_int target* scenario, the cost related to the purchase of flexibility in the non-ETS is evaluated assuming that the non-ETS GHG target for Belgium will be a reduction of 21% in 2020 compared to the 2005 level[58] (against 15% in the *20/20 target* scenario according to the burden sharing directive) and that the price of flexibility in the non-ETS is upper bounded to a figure of 30 €/t CO_2. The additional cost resulting from the stepping up to a 30% GHG reduction target fully achieved within the EU, is then calculated as the difference between this cost and the corresponding cost in the *20/20 target* scenario. This calculation leads to an additional cost of 120 million € which is equivalent to nearly 0.03% of the GDP in 2020.

The purchase of flexibility for RES production is estimated on the basis of the difference between the domestic RES shares in the *30/20_int* and *20/20 target* scenarios and a price equal to the EU average RES value in 2020 (i.e. 49.5 €/MWh). This computation leads to a negative[59] cost of some 160 million € which is equivalent to approximately 0.04% of the GDP in 2020.

All in all, the total direct cost of the *30/20_int target* scenario is projected to represent slightly less than 1.3 billion € in 2020 or 0.32% of the GDP in 2020. It is worth underlining that the large part of this cost is due to disutility costs. Indeed, if one sticks to energy related expenses, the table shows a decrease compared to the *20/20 target* scenario in 2020 (-1.6 billion €'08). This result indicates that the increase in the unit cost of energy (further to higher carbon prices in both ETS and non-ETS) is more than offset by the decrease in energy consumption.

Macroeconomic impact

Again, the macroeconomic results of the *30/20_int target scenario* will be compared with those of the *20/20* target framework and will be described according to the two usual options concerning the recycling of additional public receipts.

As shown in Table 32, the *ex ante impact* of the introduction of the carbon values on the main energy prices are much higher than in the *30/20_flex scenario*. Again, the impact is the highest for solid fuels and the smallest for electricity, gasoline, diesel oil and natural gas for industry. All in all, the average energy price would increase by 9.8% in 2020 above the *20/20* levels (a tiny bit less for households).

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58 See Bossier et al. (2008).

59 The cost is negative because the domestic RES share is higher in the *30/20_int target* scenario (13.2%) than in the *20/20 target* scenario (12.5%).

Table 32: Ex ante impacts of carbon values on energy prices, 30/20_int target scenario
% change from 20/20 target scenario

	2013	2017	2020
Solid fuels			
(a) Households and services	20.8	33.4	35.2
(b) Industry	39.2	78.3	92.8
Liquid fuels			
(a) Gasoline	4.9	8.9	10.1
(b) Diesel oil	6.6	11.5	12.3
(c) Fuel for heating	13.0	22.1	23.6
(d) Heavy fuel	16.1	27.7	30.4
Natural gas			
(a) Industry	9.4	16.2	17.8
(a) Services	11.1	19.1	20.5
(b) Households	9.5	16.8	18.3
Electricity			
(a) High tension	1.3	2.4	2.6
(b) Low tension	4.5	7.5	7.3
Average energy price	5.2	9.4	9.8
Of which households	4.8	8.9	9.3

The *30/20_int target* scenario implies a more important *increase in public receipts*[60] than in the *30/20_flex target* scenario since, in addition to much higher levels of carbon values, the whole ETS sector pays this time the auctioning rights in a context of reduced carbon leakage risk[61]. As shown in Table 33, the additional public revenues amount to about 5.65 billion € (or 1.12% of GDP) in 2020, which is more than double the level reached in the *30/20_flex target* scenario. 1.73 billion are estimated to come from the auctioning of emission rights in the ETS sector, the remaining 3.92 billion resulting from the taxation in the non-ETS sector. Once again, the purchase related to the use of flexibility mechanisms by the non-ETS sector is deducted from those new public receipts.

Table 33: Additional public receipts generated by the moving from the 20/20 target scenario to the 30/20_int target scenario
in bn €

	2013	2017	2020
(1) Industry (auctioning)	0.65	1.39	1.73
(2) Industry (NETS) + Services	0.76	1.37	1.46
(3) Households (lighting, heating)*	0.62	0.97	0.95
(4) Transport	0.68	1.29	1.52
(a) Households	0.26	0.50	0.60
(b) Firms	0.42	0.79	0.92
Total	2.71	5.02	5.65
In % of GDP	0.70	1.12	1.12

(*) Cost of flexible instruments deducted.

The international environment (i.e. the EU economy as a whole) is again modified according to this scenario definition. The impacts on the Belgian export market and on the import and export prices, computed by means of the European macro-econometric model NEMESIS, are given in Table 34, both for the

60 The increase in public receipts is again computed as the additional public receipts generated by the moving from the 20% GHG reduction target scenario (*20/20*) to a 30% GHG reduction target (*30/20_int*) at EU level in 2020. At the European level, the additional auctioning receipts resulting from the stepping up from the 20% EU GHG reduction target scenario (*20/20*) to a 30% GHG reduction target (*30/20_int*) would amount to about 68 billion € in 2020.

61 The following assumptions have been made. The auctioning rights paid each year by the ETS sector consist in a share, paid by all ETS industry sectors, of their respective emissions in the current year. Except for the electricity sector, this share rises linearly from 20% in 2013 to 70% in 2020. The power generation sector pays 100% of its auctioning rights on the whole period.

no recycling simulation (left part) and for the simulation where all public revenues are recycled in reductions of social contributions paid by employers (right part). The recycling of public receipts softens the impacts, which would have been significant otherwise.

Table 34: Impact on potential export market and on import and export prices, 30/20_int target scenario
% change from 20/20 target scenario

	No recycling of public receipts			Full recycling of public receipts		
	2013	2017	2020	2013	2017	2020
Potential export market	-0.49	-1.82	-2.07	-0.30	-0.90	-0.98
Import prices for Belgium	0.29	0.84	0.73	-0.02	-0.03	0.02
Export prices for Belgium	0.20	0.43	0.26	-0.08	-0.32	-0.34

The macroeconomic impact of the *30/20_int target scenario* is now presented according to the two recycling options.

No recycling of new public receipts

The main macroeconomic impacts of the *30/20_int* scenario with no recycling of public receipts are presented in the Table 36 below (left part).

The economic activity is strongly negatively affected by the large increase in energy prices implied by this scenario and by the large expected downturn of the potential export markets. In 2013, GDP is 0.15% lower than the level found in the *20/20* target scenario and, in 2020, the total loss in GDP would reach 0.80%, which means an average loss of 0.10% by year. The impact on all GDP's components is about the double of the one implied by the *30/20_flex target* scenario with no recycling of public receipts in 2020. Exports suffer a strong decrease (-1.99% in 2020) because of the deterioration of the international perspectives and because of higher export prices due to rising production costs in Belgium and in partner countries. Once again, the sharp impact on imports (-2.18% in 2020) is driven by the fall in the energy demand (-2.61%) and in domestic demand in general. Indeed, other domestic demand variables are again negatively affected by the increase in energy prices combined with a no recycling policy. Investment is reduced by 1.62% in 2020 (-2.08% for firm investment in 2020), as production takes a dive. The contraction of real household disposable income, by the rise in consumption prices (+0.89% in 2020), depresses household consumption by 1.07% in 2020 when compared to the *20/20* scenario level. Simulation results further indicate that the *30/20_int target scenario* without recycling leads to a severe drop in employment. Around 46 980 cumulated jobs (i.e. about 1% of total employment of the *20/20* scenario) could be lost in 2020 as the direct result of firms'costs' increase and the downturn of economic activity. This implies a turning up of the productivity per head (+0.3% in 2020) since firms' value added is less damaged by the policy shock than employment. Augmented (through inflation) total wages and lower firms' value-added would lead to higher unit labour costs. Finally, the share of gross operating surplus in the value added decreases by 1.59% in 2020 because of the higher energy prices and the imported inflation.

At the sectoral level, the impacts of the *30/20_int scenario* with no recycling policy on production are also about double those resulting from the implementation of the *30/20_flex scenario* with no recycling. The ranking of the sectoral productions in most and least affected by this scenario is equivalent to the one described in section 5.1.3. Here again, production in energy sector faces the highest fall, evaluated at 4.03% in 2020. It is followed by the transports and communications sector, wherein production decreases by 2.53% in comparison with the *20/20* scenario. In manufacturing industry, production is reduced by 1.29% with respect to the *20/20* scenario, a fall observed mainly in the sectors of intermediary and consumption goods. For construction, the loss percentage amounts to 1.16 in 2020. On the services side, credit and insurances suffer the most (-2.13%) while the effects on the health sector are quite limited (-0.1%). Production in the primary sector is cut by 1.32%. As far as the impacts on employment in percent are concerned, each sector keeps again the same relative position as in the *30/20_flex scenario* without recycling. The most affected sector in 2020 is other market services (-2.03%), followed by trade, hotels, restaurants (-1.5%). The employment in the agriculture and construction sectors is also much deteriorated, with a cut of 1.17% and 1.11% respectively in comparison with the *20/20 scenario*. In the transports and communications sector as a whole, in manufacturing and in energy industries, the impact of the no recycling policy is less pronounced (-0.75%, -0.48% and -0.21% respectively). Again, health sector records the lowest impact (-0.12%).

Full recycling of new public receipts in reductions of social contributions paid by employers

In this simulation, both the additional auctioning revenues and the additional carbon tax receipts are recycled in the economy through a reduction of social contributions paid by employers.

Table 35 gives the impact of this recycling policy on the social contributions paid by the different sectors. Here again, the same rate of reduction was applied *ex ante* for every sector to the legal social security contributions rate paid by employers, i.e. 14.9% in 2020. In 2020, it turns out that the total reduction would reach 5.65 billion €. The amounts of reduction in employers' social security contributions would be the most significant for the other market services, the trade, hotels and restaurants and the health care sectors and the least important for the energy sector.

Table 35: Reduction in employers' social contributions, 30/20_int target scenario, full recycling policy
in million € (except when mentioned otherwise)

	2013	2017	2020
Energy	-51	-88	-95
Intermediary goods	-248	-423	-453
Equipment goods	-147	-239	-241
Consumption goods	-199	-341	-360
Construction	-182	-336	-376
Transports and communication	-271	-496	-555
Trade, hotels, restaurants, ...	-526	-985	-1112
Credit and insurances	-177	-316	-351
Health care	-368	-730	-855
Other market services to households and services	-542	-1068	-1253
Total	-2711	-5024	-5651
Ex ante % of reduction	-9.9	-15.3	-14.9

Next, we discuss the simulation results of the selected policy, the figures of which are shown in Table 36 (right part).

The full recycling policy of public receipts in reduction of employer's social contributions considerably weakens the negative impact of the increase in energy products prices on GDP. Indeed, GDP looses only 0.15% with respect to the *20/20* scenario in 2020 in this case (i.e. an average annual loss of 0.019%). The recycling policy favours mainly the household consumption, which faces a loss of 0.33% with respect to the *20/20* scenario in 2020 (instead of more than 1% with the no recycling policy). The real disposable income remains lower than in the *20/20* scenario because consumption prices end up 0.25% higher in 2020. The inflationary effect of the large change in energy prices is weakened by the recycling policy which decreases the labour cost and the health index finishes even lower than in the *20/20* scenario in 2020. On the firm side, investment decreases also less than in the no recycling case but remains lower than its *20/20* level in 2020 because production costs stay higher in spite of the cut in the wages per head. Furthermore, as production falls, the overall impact on investment remains negative. Exports are also less depressed than under the no recycling assumption (-0.95% in 2020) but remain negatively affected by the decrease in export markets. The impact on imports of the full recycling policy (-1.24% in 2020) is less pronounced than in the no recycling case because domestic demand is less affected. The increase in employment is important under this full recycling policy. Around 73 000 cumulated jobs are created in 2020 on account of the reductions in employers' social security contributions, which amount to 25 530 jobs above the *20/20* scenario number (i.e. +0.53%). As a result, the productivity per head faces a fall. As for the unit labour costs, they are sharply cut with the implementation of this labour-favouring policy (they were increasing with the no recycling of public revenues).

The implementation of the *30/20_int scenario* with full recycling has a negative effect on total production in most sectors. However, the impacts are lower than the ones observed under the no recycling assumption of public revenues. The fall in production is the highest for energy (-3.09% in 2020) and the transports and communication sector (-1.31% in 2020). The remaining sectors are quite moderately affected so that the recycling policy under analysis largely contributes to attenuate the negative impact of energy prices' increases on these sectors. Only one sector records a (limited) positive impact on production in 2020 while compared to the *20/20* scenario: health sector. Finally, most sectors record a net positive impact with respect to the *20/20 target* scenario from the full recycling policy in terms of employment. The positive effects are the largest for the manufacturing industries (+1.24% for both equipment goods and consumption goods in 2020) and for construction (+1.53%). For other market services, trade, credit and insurances, health, as well as transports and communication, the gains with respect to the *20/20 target* scenario are less pronounced (between +0.27% and +0.77%). What is more, in two sectors, employment remains lower than its *20/20 target* scenario level: agriculture (losing 0.2% in 2020) and energy (-0.13% in 2020).

Table 36: Macro-economic results, 30/20_int target scenario, no recycling policy vs. full recycling policy
% change from 20/20 target scenario

	No recycling of public receipts			Full recycling of public receipts		
	2013	2017	2020	2013	2017	2020
MAIN MACROECONOMIC RESULTS						
Total production	-0.33	-1.46	-1.67	-0.14	-0.67	-0.74
Energy (Final expenditures, in 2000 prices)	-0.11	-2.15	-2.61	-0.06	-1.89	-2.23
Demand components (volumes)						
Households consumption	-0.17	-0.85	-1.07	0.01	-0.20	-0.33
Investments	-0.29	-1.27	-1.62	-0.18	-0.60	-0.76
of which Firms	-0.39	-1.65	-2.08	-0.25	-0.85	-1.07
Total internal demand	-0.20	-0.77	-0.96	-0.06	-0.26	-0.37
Exports of goods and services	-0.52	-1.78	-1.99	-0.31	-0.91	-0.95
Imports of goods and services	-0.58	-1.86	-2.18	-0.45	-1.10	-1.24
GDP	-0.15	-0.71	-0.80	0.05	-0.13	-0.15
Deflator of private consumption	0.47	1.06	0.89	0.28	0.39	0.25
Health index	0.37	0.77	0.52	0.16	0.07	-0.15
Total employment						
in thousands	-3.72	-33.34	-46.98	9.53	22.80	25.53
in %	-0.08	-0.71	-0.98	0.21	0.49	0.53
Productivity per head (market branches)	-0.07	0.07	0.30	-0.20	-0.73	-0.81
Unit labour cost (Market branches)	0.39	0.62	0.10	-1.42	-1.92	-2.07
Real disposable income	-0.41	-0.95	-1.10	-0.26	-0.45	-0.50
Gross operating surplus of firms (ratio)	-0.49	-1.31	-1.59	0.67	0.10	-0.22
Current external balance (% of GDP)	0.12	0.08	0.04	0.00	-0.09	-0.06
Net lending/borrowing of the public authorities						
Million €-current prices	2127.77	2625.94	2645.72	284.88	206.33	140.88
-% of GDP	0.57	0.60	0.52	0.08	0.04	0.01

	No recycling of public receipts			Full recycling of public receipts		
	2013	2017	2020	2013	2017	2020
MAIN SECTORAL RESULTS						
PRODUCTION (volumes)						
Agriculture	-0.60	-1.26	-1.32	-0.31	-0.25	-0.24
Energy	0.30	-3.16	-4.03	0.43	-2.44	-3.09
Manufacturing industries	-0.50	-1.21	-1.29	-0.20	-0.26	-0.16
Intermediary goods	-0.61	-1.65	-1.67	-0.29	-0.55	-0.31
Equipment goods	-0.40	-0.72	-0.79	-0.16	-0.14	-0.16
Consumption goods	-0.44	-1.01	-1.14	-0.11	-0.02	0.00
Construction	-0.40	-1.37	-1.16	-0.16	-0.36	-0.27
Transports and communication	-0.60	-2.19	-2.53	-0.41	-1.22	-1.31
Transport by rail	-0.98	-3.48	-3.71	-0.57	-1.71	-1.70
Road transport	-0.69	-2.21	-2.48	-0.43	-1.10	-1.07
Water and air transport	-0.85	-2.99	-3.58	-0.64	-1.87	-2.09
Other transports and communication	-0.53	-2.02	-2.35	-0.37	-1.15	-1.26
Trade, hotels, restaurants, ...	-0.43	-1.54	-1.76	-0.19	-0.57	-0.64
Credit, insurances	-0.34	-1.78	-2.13	-0.18	-0.77	-0.85
Health	-0.03	-0.18	-0.10	0.09	0.02	0.05
Other market services	-0.36	-1.38	-1.63	-0.23	-0.66	-0.74
Total market branches	-0.38	-1.50	-1.70	-0.17	-0.64	-0.69
EMPLOYMENT						
Agriculture	-0.06	-0.57	-1.17	-0.03	-0.11	-0.20
Energy	0.04	-0.19	-0.21	0.06	-0.13	-0.13
Manufacturing industries	-0.09	-0.32	-0.48	0.00	0.50	0.90
Intermediary goods	-0.08	-0.35	-0.56	-0.01	0.20	0.33
Equipment goods	-0.13	-0.31	-0.40	-0.01	0.61	1.24
Consumption goods	-0.09	-0.30	-0.44	0.02	0.71	1.24
Construction	-0.29	-1.20	-1.11	0.83	1.48	1.53
Transports and communication	-0.10	-0.58	-0.75	0.24	0.32	0.27
Transport by rail	-0.21	-0.81	-0.97	0.14	0.10	0.14
Road transport	-0.08	-0.61	-0.79	0.17	0.24	0.16
Water and air transport	-0.06	-0.87	-1.70	0.28	0.88	1.15
Other transports and communication	-0.10	-0.53	-0.66	0.28	0.36	0.31
Trade, hotels, restaurants, ...	-0.10	-0.99	-1.50	0.22	0.53	0.48
Credit, insurances	-0.02	-0.69	-1.26	0.12	0.54	0.65
Health	-0.02	-0.14	-0.12	0.16	0.57	0.77
Other market services	-0.13	-1.48	-2.03	0.38	0.63	0.56
Total market branches	-0.10	-0.87	-1.19	0.26	0.60	0.65

5.2.4. Variant - the 30/20_int_alt3 target scenario

Similarly to the analysis presented in section 5.1.4, this section proposes an evaluation of the effect of stepping up to -30% in a situation where higher GHG reductions are required domestically (i.e. on the Belgian territory) in the non-ETS.

To do so, an alternative scenario (or variant) has been designed that limits the use of flexibility mechanisms in Belgium in the *30/20_int target* scenario. In this scenario, called *30/20_int_alt3 target*, domestic GHG emission reductions in the non-ETS are set equal to -17%[62] in 2020 compared to 2005. This is more than in the *30/20_int target* scenario (i.e. -14.3%). This scenario is characterized by higher carbon prices in the non-ETS sectors. In 2020, the CV in the non-ETS is evaluated at 82.4 €/t CO_2, against 55.4 €/t CO_2 in the *30/20_int target* scenario.

Impact on GHG emissions

Table 37 below compares the impact of a stepping up to -30% on GHG emissions when flexibility is fully used in the non-ETS in Belgium (first column) and when this use is limited (second column).

Table 37: GHG emissions in Belgium, 30/20_int_alt3 target scenario vs. 30/20_ int target scenarios, year 2020

			30/20_int target scenario	30/20_int_alt3 target scenario
Prices	ETS	CV (€/tCO_2)	55.4	55.4
	Non-ETS	CV (€/tCO_2)	55.4	82.4
	RES	RV (€/MWh)	82.0	82.0
Quantities	Total GHG	wrt 2005 (%)	-22.0	-23.7
		wrt 20/20 (%)(*)	-9.4	-10.0
	ETS GHG	wrt 2005 (%)	-32.4	-32.5
		wrt 20/20 (%)(*)	-12.2	-14.9
	Non-ETS GHG	wrt 2005 (%)	-14.3	-17.0
		wrt 20/20 (%)(*)	-7.6	-6.7

Source: PRIMES, NTUA.
wrt = with respect to.
(*): wrt *20/20 target* scenario for column "full flexibility"; wrt *20/20_alt1 target* scenario for column "limited flexibility".

In 2020, the total GHG emission reduction from 2005 level is nearly 2 percentage points lower when flexibility is limited in the non-ETS in Belgium (-23.7% vs. -22.0%). The difference comes mainly from the non-ETS; the GHG emission reduction in the ETS stays quasi unchanged (-32.5% vs. -32.4%).

62 According to the Decision on the non-ETS, Belgium is allowed to use credits from GHG emission reduction projects in third countries up to a quantity representing 4% of its GHG emissions in the non-ETS in 2005. This leads to a domestic reduction effort of 17% in the non-ETS in 2020 (i.e. 21% - 4% = 17%).

Impact on the energy system

The impact on the Belgian energy system of a stepping up to -30% when there is a limited access to flexibility in the non-ETS sector in Belgium (reflected by a higher CV) is summarized below. The impact is first provided in percentage change compared to the *20/20_alt1 target scenario* in 2020 and then compared to the corresponding figures described in section 5.2.1[63] (figures in brackets):

- Total final energy demand is projected to be 6% lower (compared to 5.4%). Final energy consumption drops further in the residential and tertiary sectors. The additional drop concerns essentially gas and electricity whilst the final consumption of RES increases, though a little;
- Power generation decreases by 5.2% (compared to 2.8%). The extra decrease in electricity generation concerns essentially natural gas;
- Gross inland consumption decreases by 5.7% (compared to 4.8%).

Impact on direct cost

Table 38 compares the direct cost of the stepping up to -30% in the two different contexts. In the first case (column "30/20_flex target scenario"), flexibility is fully used by the Member States (i.e. uniform non-ETS carbon value across the EU) for the achievement of their GHG emission targets in the non-ETS[64]. For Belgium, the GHG emission reduction achieved domestically in the non-ETS amounts then to 14.3%. The direct cost is the additional cost compared to *20/20 target* scenario. In the second case (column "30/20_flex_alt2 target scenario"), the flexibility for the achievement of the non-ETS GHG emission target is limited in Belgium, i.e. the GHG reduction percentage in the non-ETS is set equal to 17%. The direct cost is here the additional cost compared to *20/20_alt1 target* scenario.

Table 38 shows that imposing a limit on the use of flexibility in Belgium for the achievement of the non-ETS target[65] raises the total direct cost of the stepping up to -30% by approximately 19%. The difference between both cases is of the order of 230 million €'08 in 2020; it comes mainly from the increase in the cost related to domestic effort and more specifically from disutility costs.

Table 38: Total direct cost, 30/20_int_alt3 target scenario vs. 30/20_int target scenario, year 2020
in million €'08

		30/20_int target scenario	30/20_int_alt3 target scenario
Cost related to domestic effort	A	1340	1600
of which energy related expenses		-1600	-2000
Purchase of flexibility in non-ETS	B	120	80
Purchase of flexibility for RES target	C	-160	-150
Total direct cost	A+B+C	1300	1530

Source: PRIMES, NTUA, own calculations.
N.B. Costs presented in the table are additional costs with respect to the *20/20 target* scenario for the *30/20_int target* scenario; with respect to the *20/20_alt1 target* scenario for the *30/20_int_alt3 target* scenario.

Indeed, a higher effort domestically in the non-ETS translates into more savings in energy related expenses: 2.0 billion €'08 in 2020 vs. 1.6 billion €'08 in the *30/20_int target* scenario.

63 i.e. when full flexibility is used in the non-ETS in Belgium.
64 For Belgium, the target is assumed to be -21% if there is a stepping up to -30%, against -15% in the current climate-energy legislative package associated to the -20% target at EU level in 2020.
65 In the 30/20_int_alt3 scenario, the purchase of flexibility in non-ETS is calculated assuming a carbon price of 30 €/t CO_2.

Macroeconomic impact

The macroeconomic impacts of the *30/20_int_alt3 target* scenario, obtained while comparing the new levels with the levels of the *20/20_alt1* scenario, will be presented briefly in what follows.

The *ex-ante* energy prices increase derived from the implementation of the scenario is, on average, of about 11.5% in comparison with the *20/20_alt1* in 2020. This impact is, on average, lower than in the *30/20_int target scenario* in the first half of the period under consideration but becomes higher when approaching 2020[66].

The amount of new public receipts[67] collected thanks to this particular emissions' reduction policy remains lower than in the *30/20_int* scenario in the first sub-period but ends up at 6.1 billions € (1.21% of GDP) in 2020, which is an amount slightly superior to the one found in the *30/20_int* scenario. The same rate of reduction was applied *ex ante* in every sector to the legal social security contributions rate paid by employers, i.e. 16.2% in 2020.

Table 39: Ex ante impacts of carbon values on energy prices and additional public receipts, 30/20_int_alt3 target scenario

	2013	2017	2020
Average energy price (% change from 20/20_alt1)	3.6	8.4	11.5
Of which households	3.2	8.4	11.9
Total new public receipts (difference with 20/20_alt1 in bn €)	1.8	4.3	6.1
In % of GDP	0.47	0.96	1.21

Since the variant concerns only Belgium, it was assumed that the international environment was modified in the same way as in the *30/20_int* scenario (see Table 34 for the change of the potential export market, export prices and import prices for Belgium).

No recycling of new public receipts

The main macroeconomic impacts of the *30/20_int_alt3* scenario with no recycling of public receipts are presented in the Table 40 below.

As in the main simulation, the *30/20_int_alt3 scenario* with no recycling of public receipts would imply large impacts on the Belgian activity. It would result in a loss of GDP of 0.83% with respect to its *20/20_alt1* level in 2020, which is slightly more negative than in the *30/20_int* scenario (with no recycling). Once more, exports and imports are particularly strongly impacted with a loss of 2.02% and 2.17% (respectively) in comparison with the *20/20_alt1* scenario in 2020. While imports face the same impact as in the *30/20_int target* scenario (with no recycling) at the end of the period, exports are deteriorated as Belgium, intensifying its emission reduction effort, deteriorates its price competitiveness. On the domestic demand side, household consumption ends up 1.05% lower than in the *20/20_alt1*. This loss is about the same as in the *30/20_int scenario* (with no recycling), since the real disposable income is cut in the same proportion. Investment is again badly affected from increasing production costs (-2.09% for firm's investment with respect to the *20/20_alt1* scenario in 2020). About 46 160 cu-

[66] The explanation of this particular energy prices evolution is to be found in the electricity prices differential given by PRIMES.

[67] The new public receipts are again computed as the additional public receipts generated by the moving from the variant for Belgium of 20% EU GHG reduction target scenario (*20/20_alt1*) to the variant for Belgium of the 30% EU GHG reduction target (*30/20_int_alt3*) in 2020.

mulated jobs could be lost in 2020 as the direct result of firms' costs increase and the brake in economic activity, which is very close to the loss recorded in the 30/20_*int* scenario (with no recycling).

As far as the sectoral impacts on production and employment are concerned, the most badly affected sectors (energy and transports and communication sectors as far as production is concerned; other market services, trade, hotels and restaurants as far as employment is concerned) are the same as in the *30/20_int scenario* (with no recycling). In the same way, the less badly affected sector (i.e. health sector as far as both production and employment are concerned) is also the one found in the *30/20_int scenario* (with no recycling).

Full recycling of new public receipts in reductions of social contributions paid by employers

The main macroeconomic impacts of the *30/20_int_alt3* scenario with recycling of public receipts are presented in the Table 40 below (right part).

The *30/20_int_alt3 scenario* with recycling of public receipts in reductions of social contributions paid by employers shows macroeconomic results very similar to those of the *30/20_int target* scenario (with recycling). Indeed, this scenario would result in a tiny loss of 0.14% of GDP with respect to the *20/20_alt1* in 2020. Although GDP's components benefit considerably directly or indirectly from the recycling policy, they all remain under their *20/20_alt1* scenario levels in 2020. Exports and imports stay badly impacted, ending up with 0.96% and 1.24% (respectively) below their *20/20_alt1*'s levels. On the domestic demand side, household consumption is decreased by 0.30% in comparison with the *20/20_alt1 scenario* at the end of the period (an impact very close to the one found in the main scenario). Investment suffers again from production costs which remain on average higher than in the *20/20_alt1* in spite of the reduction in employers' social contributions (-1.07% for firm's investment compared to the *20/20_alt1* in 2020). About 23 590 cumulated jobs could be added to those of the *20/20_alt1* scenario in 2020 as the positive effect of the cut in labour price. This represents a somewhat narrower net impact than in the main scenario, due to the smaller amounts of recycled public receipts during the first years of the simulation.

Regarding the sectoral impacts, the sectors whose production remains the most badly affected (i.e. energy and transports and communication) or whose employment remains under the *20/20_alt1* scenario in spite of the recycling (agriculture and energy) are the same as in the *30/20_int scenario* (with recycling). In the same way, the less badly affected or even benefiting sectors in terms of production (health and consumption goods) or the most benefiting sectors in terms of employment (construction, consumption goods and equipment goods) are also those found in the *30/20_int scenario* (with recycling).

Table 40: Macro-economic results, 30/20_int_alt3 target scenario, no recycling policy vs. full recycling policy
% change from 20/20_alt1

	No recycling of public receipts			Full recycling of public receipts		
	2013	2017	2020	2013	2017	2020
MAIN MACROECONOMIC RESULTS						
Total production	-0.29	-1.28	-1.72	-0.17	-0.61	-0.78
Energy (Final expenditures, in 2000 prices)	-0.35	-1.97	-3.01	-0.32	-1.76	-2.65
Demand components (volumes)						
Households consumption	-0.12	-0.69	-1.05	0.00	-0.15	-0.30
Investments	-0.23	-1.11	-1.63	-0.15	-0.56	-0.77
of which Firms	-0.31	-1.46	-2.09	-0.22	-0.80	-1.07
Total internal demand	-0.15	-0.65	-0.95	-0.06	-0.23	-0.35
Exports of goods and services	-0.47	-1.69	-2.02	-0.30	-0.88	-0.96
Imports of goods and services	-0.48	-1.71	-2.17	-0.37	-1.01	-1.24
GDP	-0.14	-0.65	-0.83	-0.00	-0.14	-0.14
Deflator of private consumption	0.32	0.93	1.11	0.18	0.35	0.45
Health index	0.28	0.74	0.76	0.13	0.13	0.06
Total employment						
in thousands	-3.16	-28.82	-46.16	5.66	15.66	23.59
in %	-0.07	-0.61	-0.96	0.13	0.33	0.49
Productivity per head (market branches)	-0.07	0.03	0.25	-0.16	-0.56	-0.75
Unit labour cost (Market branches)	0.31	0.62	0.36	-0.91	-1.65	-2.14
Real disposable income	-0.27	-0.81	-1.15	-0.17	-0.39	-0.56
Gross operating surplus of firms (ratio)	-0.34	-1.16	-1.70	0.43	0.12	-0.14

6. Annex

6.1. Detailed energy and CO_2 emissions' figures for the different scenarios

		2005	2020 Baseline	2020 20/20 target	2020 30/20_flex target	2020 30/20_int target
Gross inland consumption (ktoe)		60605	59264	58138	56618	55312
Solids		5450	4845	3586	2950	2323
Oil		24747	21927	21136	20699	20332
Natural gas		14740	15533	13949	13517	13153
Nuclear		12277	12405	12405	12405	12405
RES		3391	4553	7062	7046	7098
Final energy demand (ktoe)		38443	39312	38937	37817	36820
by sector	Industry	13563	13706	13649	13562	13292
	Residential	9938	10249	10149	9576	9167
	Tertiary	5017	5501	5352	4995	4744
	Transport	9926	9856	9787	9684	9618
by fuel	Solids	2080	1750	1767	1644	1371
	Oil	16529	15254	14593	14132	13816
	Gas	10009	10556	9656	9204	8894
	Electricity	6894	7821	7681	7551	7509
	Heat	427	1224	1208	1245	1270
	RES	2503	2706	4031	4041	3959
Net electricity generation (GWh)		82043	87839	86172	84436	83794
Nuclear		45109	45808	45808	45808	45808
RES		3363	12755	18579	18562	19730
Solids		7561	7988	2924	1061	0
Oil		1687	2401	1393	1519	1082
Natural gas		21761	16491	15000	15110	14992
Derived gases		2563	2395	2468	2377	2182
Net installed power capacity(MW)		14716	20348	20681	20625	20920
Nuclear		5817	5941	5941	5941	5941
RES		841	4680	6174	6118	6415
Solids		1709	1079	1079	1079	1079
Oil		639	1410	637	637	637
Gas		5710	7238	6850	6850	6848
Energy related CO_2 emissions (Mt)		107.7	100.2	89.2	84.3	79.9
Power & energy sectors		24.7	21.4	14.4	12.5	11.0
Industry		22.7	20.2	19.2	18.4	17.2
Residential		20.4	20.1	18.7	17.5	16.5
Tertiary		10.5	11.0	10.5	9.8	9.3
Transport		29.5	27.5	26.4	26.1	25.9
of which intern. aviation		3.8	4.5	4.6	4.4	4.4
Carbon value (€'08/tCO_2)						
ETS		0.0	25.0	16.5	30.2	55.4
non-ETS		0.0	0.0	5.3	30.2	55.4
Renewable value (€'08/MWh)		0.0	82.0	82.0	82.0	82.0

Source: PRIMES.

6.2. Some additional comparative numbers regarding flexibility in the non-ETS

		20/20 target	20/20_alt1 target	30/20_flex target	30/20_flex_alt2 target
Gross inland consumption (ktoe)		58138	57948	56618	55924
Solids		3586	3907	2950	2783
Oil		21136	20861	20699	20439
Natural gas		13949	13700	13517	13262
Nuclear		12405	12405	12405	12405
RES		7062	7074	7046	7034
Final energy demand (ktoe)		38937	38524	37817	37239
by sector	Industry	13649	13636	13562	13556
	Residential	10149	9922	9576	9248
	Tertiary	5352	5254	4995	4800
	Transport	9787	9712	9684	9636
by fuel	Solids	1767	1736	1644	1630
	Oil	14593	14297	14132	13879
	Gas	9656	9511	9204	8951
	Electricity	7681	7805	7551	7508
	Heat	1208	1252	1245	1244
	RES	4031	3924	4041	4028
Net electricity generation (GWh)		86172	87703	84436	83865
Nuclear		45808	45808	45808	45808
RES		18579	18931	18562	18568
Solids		2924	4276	1061	461
Oil		1393	1094	1519	1519
Natural gas		15000	15106	15110	15132
Derived gases		2468	2488	2377	2377
Net installed power capacity (MW)		20681	20904	20625	20626
Nuclear		5941	5941	5941	5941
RES		6174	6236	6118	6118
Solids		1079	1079	1079	1079
Oil		637	726	637	637
Gas		6850	6923	6850	6850
Energy related CO_2 emissions (Mt)		89.2	89.1	84.3	82.3
Power & energy sectors		14.4	15.6	12.5	11.9
Industry		19.2	19.2	18.4	18.4
Residential		18.7	17.8	17.5	16.6
Tertiary		10.5	10.2	9.8	9.4
Transport		26.4	26.2	26.1	26.0
of which international aviation		4.6	4.6	4.4	4.4
Carbon value (€'08/tCO_2)					
ETS		16.5	16.5	30.2	30.2
non-ETS		5.3	41.5	30.2	50.7
Renewable value (€'08/MWh)		82.0	82.0	82.0	82.0

Source: PRIMES.

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