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EU Energy/Climate package and energy supply security in Belgium

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Abstract – In December 2008, the European Union adopted an integrated Energy/Climate package which steps up the Union's energy and climate policy ambitions to a new level and outlines how the effort will be shared among the Member States. This paper underlines the benefits of the EU Energy/Climate package in terms of energy supply security for Belgium, and more specifically the positive impacts the twin target – greenhouse gas emissions reduction and development of renewable energy sources – has on our dependence on fossil fuels. More specifically, the paper shows that substitutions in favour of renewables and a decrease in energy demand including the demand for electricity, which are the key responses of the Belgian energy system to the Energy/Climate package, not only allow to keep a balanced fuel mix in power generation in 2020 but also lead to reduced overall fossil fuel imports relative to baseline projections. They also water down the trend towards an increased dependency on natural gas imports. Net imports of fossil fuels decrease by 9% in 2020 compared to baseline trends. Compared to the year 2005, they increase only slightly by 3%. The growth of natural gas imports is limited to 11% over the same period, against +21% in the baseline.

Jel Classification – Q4, C6, O2

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Executive Summary

In December 2008, the 27 Member States of the European Union adopted an integrated Energy/Climate package which steps up the European Union's energy and climate policy ambitions to a new level and outlines how the effort will be shared among the Member States. One key element of the E/C package is the set up of a twin target for the year 2020: a reduction target for EU greenhouse gas emissions (-20% compared to the 1990 level) on the one hand, and a development target for renewable energy sources in the EU (20% of gross final energy demand) on the other hand. These two targets influence one another and bring along both costs and benefits.

The aim of this paper is to focus on the benefits in terms of long term energy supply security for Belgium, and more specifically on the positive impacts the twin target has on our dependence on fossil fuels. The reduction of energy imports in a country like Belgium is particularly important given that the Belgian soil does not contain any fossil fuel resource, that the potential of renewable energy sources is to a certain extent relatively limited, that no new nuclear power plants can be constructed and that an upper limit on the operational lifetime of existing nuclear power plants is determined by law. The law of 2003 stipulated that the limit was set at maximum 40 years, but that law is now being amended as to allowing the three oldest nuclear power units to function 50 years (see infra).

The quantitative material presented in this paper originates from a study the Federal Planning Bureau (FPB) performed for the Belgian federal and three regional authorities in 2008 that later on transformed into the FPB's WP21-08 (Bossier et al., 2008). That study presumes that all existing nuclear power plants will be decommissioned after 40 years of operation according to the law of 2003 on the nuclear phase out. In October 2009, however, the government decided to extend the operational lifetime of the three oldest nuclear reactors, totalling 1800 MW, with 10 more years. An estimate of the impact of this recent decision on energy imports is added to the original analysis.

The study shows that substitutions in favour of renewables and a decrease in energy demand including the demand for electricity, which are the key responses of the Belgian energy system to the Energy/Climate package, lead to ***a reduction in overall fossil fuel imports of 9% relative to baseline projections in 2020*** (about two thirds of the reduction are due to energy savings and one third to the development of renewables). In monetary terms, this effect translates into 1.2 billion € savings compared to the baseline in 2020 (i.e. 0.7 billion € for oil, 0.4 billion € for natural gas and 0.1 million € for coal).

On the other hand, while fossil fuel imports do shrink considerably, ***biomass imports are expected to rise*** triggered by the RES development target since the production of domestic biomass is rather limited in Belgium. According to the literature on the matter, about one half to two thirds of the biomass supply needed to fulfil the Energy/Climate package will have to be im-

ported. Taking the uncertainty surrounding the future biomass prices into account, biomass imports will represent a supplementary import cost between 200 and 380 million € in 2020, compared to baseline. ***All in all, the Energy/Climate package results into a net energy import gain in 2020 of 0.83 to 1 billion € compared to baseline***.

By extending the operational lifetime of the three oldest nuclear power plants, a further 0.33 billion € could be saved in 2020 at the import side by avoiding fossil fuel based power generation.

The paper pays particular attention to the impact of the Energy/Climate package on natural gas imports and shows that concerns about the security of Belgian natural gas supply can be watered down, in 2020, by the twin GHG/RES target.

Unlike previous studies dealing only with the effect of greenhouse gas reduction constraints (i.e. not including simultaneously a target on RES deployment) on the fuel mix in Belgium and showing a 'dash for gas' in the power generation sector which may be problematic for the security of our future energy supply, this analysis leads to a more balanced fuel mix in power generation in 2020 and to a moderate growth of natural gas imports.

Further to the implementation of the Energy/Climate package, ***natural gas covers no more than one third of the Belgian power generation***, compared to almost 50% in the absence of a RES target. The reasonable penetration of natural gas in the power sector combined with a decrease in electricity consumption compared to the baseline leads to ***a modest increase in natural gas imports by 11% between 2005 and 2020*** (i.e. 0.5% per year on average) against +21% in the baseline (i.e. 1% per year on average).

Key results of the analysis are summarized in the table below.

Table 1: Summary of the impact of the EU Energy/Climate package on Belgian energy imports in 2020

	2005	2020		Evolution between 2005 and 2020		Import savings(**) in 2020		
		baseline	E/C package(*)	baseline	E/C package(*)	compared to baseline		
	(Mtoe)	(Mtoe)	(Mtoe)	(%)	(%)	(Mtoe)	(%)	(billion €)
Fossil fuels	48.1	54.4	49.5	13%	3%	4.8	9%	1.2
Oil	28.4	29.3	27.4	3%	-4%	1.9	6%	0.7
Nat. gas	14.2	17.2	15.8	21%	11%	1.5	9%	0.4
Coal	5.5	7.8	6.4	41%	15%	1.4	19%	0.1
Biomass	0.3	[0.8;1.5]	[1.8;2.5]	[185; 434]%	[541; 790]%	-1.0	-67%	[-0.4; -0.2]
All fuels(***)	48.4	55.9	52.0	15%	7%	3.8	7%	[0.8; 1.0]

(*): i.e. the *20/20 target scenario* (see infra).

(**): Positive (negative) figures mean a decrease (increase) in net imports or net import costs.

(***): Figures presented correspond to the highest estimate for biomass imports.

Contents

List of figures

List of tables

1. Introduction

In December 2008, the European Union adopted an integrated Energy/Climate package which steps up the European Union's energy and climate policy ambitions to a new level and outlines how the effort will be shared among the Member States. One key element of the E/C package is the set up of a twin target for the year 2020: a reduction target for EU greenhouse gas emissions (-20% compared to the 1990 level), on the one hand, and a development target for renewable energy sources in the EU (20% of gross final energy demand), on the other hand. These two targets influence one another (i.e. the former helps to achieve the latter and vice versa) and bring along both costs and benefits.

The aim of this paper is to focus on the benefits in terms of long term energy supply security for Belgium, and more specifically on the positive impacts of the twin target on our dependence on fossil fuels. The reduction of energy imports in a country like Belgium is particularly important given that the Belgian soil does not contain any fossil fuel resource, that no new nuclear power plants can be constructed, that the operational lifetime of existing nuclear power plants is limited by law and that the potential of renewable energy sources is to a certain extent relatively limited.

Particular attention is paid to the impact on natural gas imports because previous studies dealing only with the effect of greenhouse gas reduction constraints (i.e. not including simultaneously a specific constraint on the deployment of renewable energy sources by 2020) on the fuel mix in Belgium showed a 'dash for gas' in the power generation sector which may be problematic for the security of our future energy supply.

The quantitative material presented in this paper originates from a study the Belgian Federal Planning Bureau (FPB) performed for the Belgian federal and three regional authorities in 2008 that later on transformed into the FPB's WP21-08 (Bossier et al., 2008). It therefore does not include the short term and likely long term impact of the economic and financial crisis on energy consumption and production patterns. However, as the present analysis focuses on changes with respect to a baseline trend (i.e. not including the twin target) one can reasonably expect that the conclusions drawn in the original study will remain robust at the horizon of 2020.

2. Policy background

2.1. The EU Energy/Climate package

In 2007, the European Union stepped up its energy and climate change ambitions to a new level. Based on several communications by the European Commission on an Energy and Climate Policy for Europe, the EU Council agreed to:

– An independent greenhouse gas (GHG) emission reduction commitment of 20% by 2020 compared to 1990 levels and an objective for a 30% reduction by 2020 subject to the conclusion of a comprehensive international climate change agreement,
– A mandatory 20% share of renewable energy sources (RES) in gross final energy demand by 2020 for the EU as a whole including a 10% share of renewables in transport for each Member State, and
– An improvement of energy efficiency by 20% compared to baseline levels by 2020.

The Council recognized that the implementation of these targets should be based on a combination of Community measures and on efforts to be undertaken by Member States. In January 2008 the European Commission came forward with an integrated package of concrete proposals, including how efforts could be shared among Member States to achieve these targets (the so-called Energy/Climate package). For GHG emissions, the proposal focuses on a 20% reduction target with possibilities and principles for an effort increase to a -30% scenario in case a comprehensive international climate change agreement is reached.

The emission reductions for sectors under the EU ETS[1] are addressed at Community level. The emission reduction effort in the non-ETS sectors (mainly transport, tertiary and residential sectors) is shared among the Member States on the basis of a GDP per capita distribution key. Moreover, the distribution of the renewable energy target is based on a combination of a flat rate approach and the GDP per capita criterion.

In December 2008, the EU Energy/Climate package became a legislative package. Adopted by the European Parliament on December 17, 2008 and by the Council of the European Union on April 6, 2009, the package includes the following acts published in the Official Journal on June 5, 2009[2]:

– New rules promoting the use of energy from renewable sources (Directive 2009/28/EC);
– Revised EU Emission Trading System (Directive 2009/29/EC);
– EU Member States effort sharing to make GHG emission reductions in the non-ETS sectors (Decision No 406/2009/EC);
– New rules for cleaner cars in Europe (Regulation (EC) No 443/2009);

1 Emission Trading System.
2 http://eur-lex.europa.eu/JOHtml.do?uri=OJ:L:2009:140:SOM:EN:HTML

– New environmental quality standards for fuels and biofuels (Directive 2009/30/EC);
– Regulatory framework for carbon capture and storage (Directive 2009/31/EC).

2.2. Security of energy supply

With both energy consumption growing and oil and natural gas supplies becoming scarcer and more distant from consumption areas, the risk of supply failure is rising and the pressure on prices is increasing. Securing European energy supplies is high on the EU's agenda as well as on the Belgian one. The absence[3] of fossil fuel resources in the Belgian soil makes Belgium highly dependent on energy imports. Fossil fuel imports represented 87% of the country's energy needs in 2005. Moreover, this percentage is likely to increase in the years to come further to the law on the nuclear phase out. This law, adopted in 2003, prevents the construction of new nuclear power plants and foresees the decommissioning of existing nuclear power plants after 40 years of operation.

Recently, however, this law has come under discussion further to a report on the ideal energy mix for Belgium against the horizon 2020 and 2030 (Gemix, 2009) in which supply security, the country's competitive position and protection of climate and environment are key. Hence, government decided to reconsider the 2003 phase out law and to prolong the operational lifetime of the three oldest nuclear power reactors (Doel 1, Doel 2 and Tihange 1) with 10 extra years. No decision whatsoever was taken on the functional lifespan of the four youngest nuclear power plants (Doel 3, Doel 4, Tihange 2 and Tihange 3). Nuclear energy policy has, however, an impact on the use of fossil fuels, hence on fossil fuel import (see also box Impact of the governmental decision of October 2009 on the imports of fossil fuels).

Next to fossil fuel imports, there remains the possibility to import non-domestically produced biomass, especially in the light of the second target concerning renewable energy sources in gross final energy demand. This can, however, cause adverse effects when it comes to energy supply security and sustainability, equity and ethical acceptability (see Gemix, annex 3).

Besides the diversity in energy suppliers and transport routes, the promotion of energy efficiency and the development of domestic renewable energy sources contribute to the improvement of our energy supply security. These two policy areas are also of utmost importance in the fight against climate change as they help to reduce GHG emissions.

3 Belgium has some coal resources but extraction costs are prohibitive.

3. Methodology and key assumptions

The (European) energy model PRIMES is used to evaluate the impact of the EU Energy/Climate package on energy supply security in Belgium. The PRIMES model is developed and managed by ICCS/NTUA. It generates long term energy and emissions' projections on the supranational (European) and national (e.g. Belgian) level. The PRIMES model covers the energy and process related emissions of CO_2 whereas the projections of non-CO_2 greenhouse gas emissions come from the GAINS model of IIASA.

The analysis starts with a *baseline* or *reference scenario*. The *baseline* includes current trends and policies as implemented in Belgium by the end of 2006 (e.g. nuclear phase out[4], incentives for the deployment of RES, etc.). This *baseline* may come up with energy forecasts that do not lead to the realisation of indicative targets (e.g. share of RES in electricity supply in 2010) or newly decided binding targets (e.g. those set up in the E/C legislative package). In the *baseline* the development of GHG emissions or the share of RES are modelling results that inform policy makers about the effects of policies or their absence. This approach enables the *baseline* to illustrate the gap between policy ambitions and what is already underway for delivering on these policy aspirations. Therefore, the *baseline* constitutes a relevant benchmark for the subsequent evaluation of the effects of additional measures or new targets. Such measures or targets are modelled in so-called policy scenarios irrespective of the state of policy implementation (answering "what if" questions).

The *baseline* that is used for this analysis is close to the one published in April 2008 by DG TREN of the European Commission (EC, 2008). Energy developments are simulated on the basis of assumptions concerning e.g. economic and demographic forecasts, world energy markets and implemented policies. Table 2 summarizes some key assumptions of the *baseline*.

Table 2: Some key assumptions for the *baseline* for Belgium

	20//05	$(2005)/bbl	Policy
Population	0.2%		
Number of households	0.8%		
GDP (volume)	2.1%		
Oil price in 2020		61.1	
Nuclear power			Gradual phase out from 2015 on[5].
RES-electricity			Green certificates/target in 2010.
EU-ETS			National allocation plan.

Sources: EC-DG TREN (2008), Bossier et al. (2008).

//: average annual growth rate.

4 At that time, no governmental decision on the partial abolishment of the 2003 phase-out law was taken, so the baseline does take the 2003 law into account with nuclear retirement after 40 years of operation, meaning that Doel 1, Doel 2 and Tihange 1 power the Belgian consumers until 2015.

5 See footnote 4.

In a second step, the effect of the twin target for the year 2020 is scrutinized. To do so, a policy scenario named *20/20 target scenario*[6] is designed that mimics as closely as possible the E/C package. More specifically, the *20/20 target scenario* (1) integrates a 15% reduction of GHG in the Belgian non-ETS sector in 2020 compared to the level of 2005, (2) considers the effort performed by the Belgian ETS sector in the context of the emission cap set at EU level, (3) includes the Belgian target of 13% of RES in gross final energy demand and (4) takes into account the possibility to use flexibility mechanisms (i.e. to reach part of the national binding targets abroad).

In PRIMES, the installation of a constraint (be it on emissions or renewables) is equivalent to the introduction of a variable that reflects the economic cost imposed by this constraint. In the case of GHG emissions, this variable is the marginal abatement cost (also called carbon value) associated with the constraint; it represents the cost to reduce the last unit of emissions that needs to be eliminated in order to reach the set emission target. The marginal abatement cost can also be seen as the emission permits' price determined on a perfect market and of which the quantity corresponds to the constraint. The carbon value (CV) by hypothesis is unique for all sectors within the scope of the constraint (e.g. the EU-ETS, each national non-ETS sector); it causes changes in the relative prices of the different energy forms, reflecting by this the differences in the carbon content of fuels. These changes induce technological modifications/innovations and behavioural adaptations of energy producers and consumers.

When a constraint is put on RES, things are a bit different. It is here assumed that a certain positive monetary value is associated with any unit of energy produced by a renewable energy source. Such a monetary value does not involve payments but its presence alters the economic optimality of calculations of the agents. This monetary value could be interpreted as a "virtual" subsidy and enters in the model calculations as a negative unit cost (a benefit), which is called a renewables value (RV). Being a virtual subsidy, the renewables value does not make energy cheaper but just influences the optimal fuel mix as considered by each economic agent.

In concrete terms, the flexibility provided in the E/C legislative package is such that marginal abatement costs in the non-ETS sector will be equalized across EU countries. In the ETS sector, all EU companies will make use of flexibility and equal their marginal abatement cost to the permits price that is represented by the ETS carbon value. Finally, assuming flexibility in RES ensures that the production of energy from RES will take place where it is cheapest in the sense that the virtual subsidy to renewable energy production will be equalized across countries.

The corresponding carbon and renewable value in the 20/20 target scenario are given in Table 3 and compared to their level in the *baseline*.

6 The acronym stands for a 20% reduction of GHG emissions at EU level in the year 2020 compared to the level of 1990 and the EU-imposed 20% share of RES in gross final energy demand in 2020.

Table 3: Carbon and renewables values, *baseline* vs. *20/20 target scenario*, year 2020

	Baseline	20/20 target scenario
Carbon value – ETS (€/t CO_2)	22	33.5
Carbon value – non-ETS (€/t CO_2)	0	25.0
Renewables value (€/MWh)	0	49.5

Sources: NTUA, Bossier et al. (2008).

The carbon value in the non-ETS sector translates into a 'domestic reduction' of GHG emissions in the non-ETS sector of 9.2% in 2020 compared to 2005, the gap to the 15% reduction target being realized via flexibility mechanisms. Similarly, the renewables value corresponds to a share of 12.3% of RES in gross final energy demand, the gap to the 13% target being covered by flexibility.

4. Evolution of the Belgian energy system under unchanged policy

Before going into the analysis of the impact of the E/C package on energy supply security in Belgium, a short description of the *baseline* trends is provided. More specifically, a selection of relevant energy indicators is presented as well as the projected development of GHG emissions.

4.1. Gross Inland Consumption

The first indicator is the gross inland consumption (GIC). The GIC is an indicator that describes a nation's total energy needs 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 *baseline* GIC for Belgium follows a growth pattern, although moderate: from 55 Mtoe in 2005 to 59 Mtoe by 2020, i.e. +8%. Throughout the period, oil looses part of its relative weight (from a share of 37% in 2005, it falls down to 35% in 2020). Nuclear energy shares this loss: its part in GIC dives from almost a quarter in 2005 to 15% at the end of the period[7]. This is the direct consequence of the phase out of nuclear plants. Meanwhile, natural gas manages to pick up the lost shares and expands from 26% to 29%, together with solids and renewable energy sources, which, in 2020, represent respectively 13% and 6% of GIC, up from respectively 10% and 4% in 2005.

Total energy needs are allocated among power generation, other transformation sectors (e.g. refineries) and final energy and non-energy uses. As the major changes are projected to take place in power generation and in final demand sectors, we stick to these two categories.

4.2. Final Energy Demand

Final Energy Demand (FED), i.e. the energy consumption of industry, households, the tertiary sector (including agriculture) and transport, increases by 14% between 2005 and 2020. All energy forms are projected to grow but oil which stabilizes at its 2005 level in 2020: the projected increase in transport is compensated by a decrease in oil consumption in the other final demand sectors. Coal consumption increases by 33% further to the projected development of iron and steel production in blast furnace plants. The demand for natural gas grows by 12% as a result of substitution for oil products in heating uses[8] and increase in the number of households despite improvements in energy efficiency. Electricity consumption goes up steadily due to the growing electrification[9] of end-user applications: in 2020, it is 29% above the 2005 level. Finally, re-

7 As a reminder: the baseline, as well as the 20/20 target scenario, subscribe to the 2003 phase-out law on nuclear power production (see also footnote 4).

8 Both in industry and in residential/tertiary sector.

9 This wording encompasses substitution and volume effects.

newable energy sources like biomass, biofuels and solar thermal develop strongly (by 9% per year on average), but still represent the smallest share in 2020 (3%). As regards biofuels, they cover 7% of oil consumption in transport.

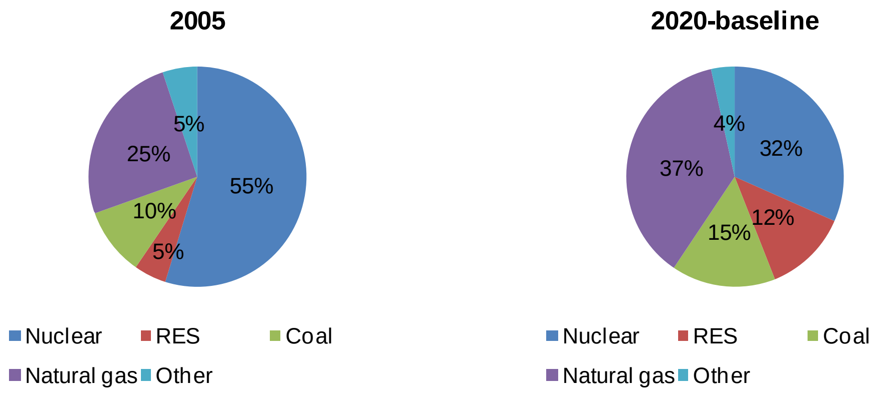
All in all, and accounting also for the share of renewables in electricity and heat final consumption, the baseline leads to a share of RES in gross final energy demand of 7.5% in 2020 against 2.1% in 2005.

4.3. Power generation

To satisfy the demand of electricity, production has to follow[10]. Net electricity generation increases from 82 TWh in 2005 to 107 TWh in 2020, i.e. +30%. The evolution of the electricity generation mix between 2005 and 2020 is depicted in Figure 1 below. A significant change in shares can be noticed: more natural gas and RES are used in 2020, the share of coal increases somewhat, while nuclear energy declines further to the 2003 phase-out law.

Investments in supercritical coal-fired plants compensate for the decommissioning of nuclear power plants for base load electricity generation, whereas the expansion of gas-fired power plants (mainly combined cycle gas turbines) is mainly caused by the additional electricity demand. Also remarkable is the significant development of power generation based on renewable energy sources whose share jumps from 5% in 2005 to 12% in 2020. This evolution results from policies in place, increase in fossil fuel prices and decrease in investment costs (thanks to the learning curves). The increased contribution of RES is primarily due to biomass and waste (7%) and secondarily to wind (5%, both onshore and offshore). The potential development of hydropower is small in Belgium and solar photovoltaic systems suffer from comparatively high costs. Together, these two RES cover less than 1% of power generation in 2020.

Figure 1: Net electricity generation (%), *baseline*, years 2005 and 2020



Sources: PRIMES, Bossier et al. (2008).
'Other' stands for oil and derived gases.

10 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 5.9 TWh in 2020, compared to 6.3 TWh in 2005.

4.4. GHG emission trends

The *baseline* leads to GHG emissions increasing by 13% in 2020 compared to 2005, i.e. a 26% increase in the ETS sector and a 4% increase in the non-ETS sector.

4.5. (Net) energy import

4.5.1. Fossil fuel import

Because Belgium has no fossil fuel resources at its disposal[11], the increase in fossil fuel consumption depicted above translates into more energy import. In 2020, Belgium will import 13% more energy than in 2005[12]. The evolution of natural gas imports is particularly worrying in the context of latest concerns about the gas supply in the European Union: +21% between 2005 and 2020. The most significant part of the increase takes place in the power generation sector where the share of electricity generated in natural gas-fired power plants jumps from 25% in 2005 to 37% in 2020. Coal imports are also projected to increase (+41% over 2005-2020) but this development causes less of a problem in terms of security of supply since coal resources are more widely spread over the globe than oil and natural gas resources. By contrast, oil imports grow only slightly: +3% between 2005 and 2020.

4.5.2. Biomass import

Next to fossil fuel resources, renewable energy sources are imported. Import of renewable energy boils down to import of (different types of) biomass. Although its importance just up to now is rather minor compared to fossil fuel import, things are bound to change in the future.

To sketch the recent situation, we look at figures from Eurostat. Between 2000 and 2007 the imported amount of biomass increased fivefold: it grew from 0.1 Mtoe in 2000 to 0.5 Mtoe in 2007. In 2000, 13% of the needed biomass was imported, while in 2007, almost half of the nation's biomass needs (44% to be exact) were dispatched from abroad. While in 2000, the entire amount of imported biomass consisted of wood and wood waste, in 2007, wood and wood waste only made up 83% of the total biomass import, the balance being filled by biofuels[13]. Main biomass suppliers are Brasil (ethanol), Canada (rapeseed, wood and wood products), Russia and the US (wood products).

When we turn to the future, we see that, over the planning horizon, gross inland consumption of biomass and waste grows spectacularly (+57% from 2005 to 2020). Given that the domestic biomass potential is rather limited in Belgium, we can safely suppose that, as is the case today, part of that growth will have to be imported. Following the literature (J. De Ruyck, 2006, EEA,

11 At reasonable production costs.

12 From 48.1 Mtoe in 2005 to 54.4 Mtoe in 2020.

13 In 2007, 80% of biofuels' import was biodiesel, the remaining 20% being made up of other liquid biofuels. According to VITO (2009), this allocation will most likely change in the future, when the share of imported biodiesel will decline (primarily due to every MS's 10% RES in transport target) to the benefit of ethanol import.

2006, GEMIX, 2009), we can assume that, in the baseline, between a quarter to a half of the Belgian biomass needs in 2020 will have to come from across our borders[14]. This signifies that, in terms of total Belgian biomass needs in 2020 of 3.1 Mtoe, 0.8 to 1.5 Mtoe has to be imported.

[14] These figures are coherent with the sum of the figures stated in VITO (2009) and the PMDE (2009).

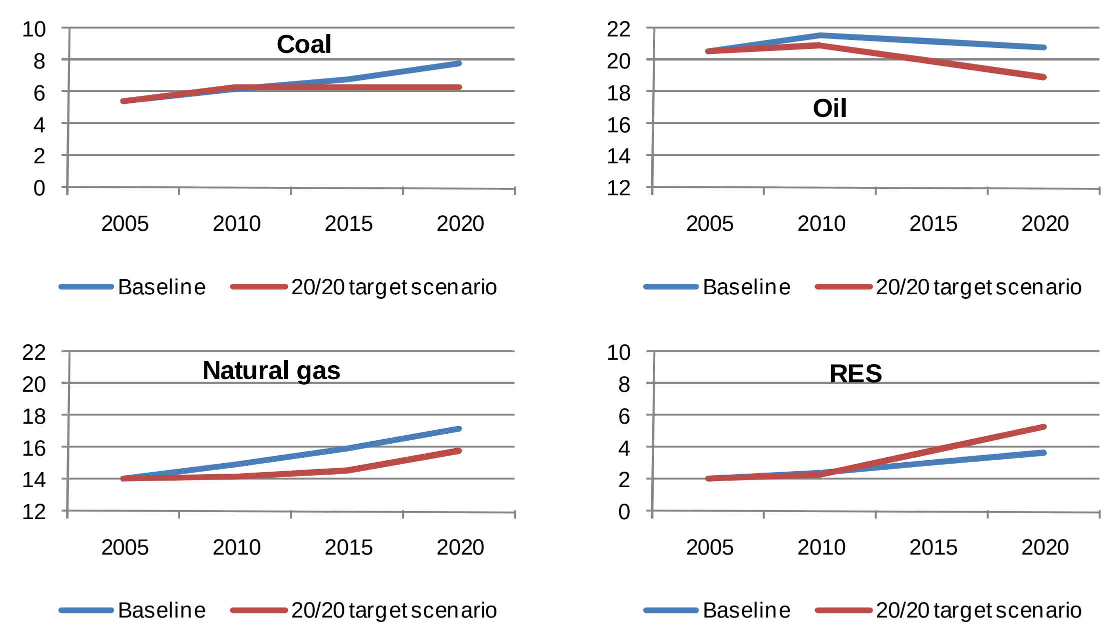
5. The impact of the E/C package on Belgium's energy dependence

Energy savings and further RES deployment are the main responses of the Belgian energy system to the GHG/RES twin target. A more detailed analysis of the impact is provided below using the same set of indicators as for the baseline (cf. section 4).

5.1. Gross Inland Consumption

The implementation of the *20/20 target scenario* through the introduction of appropriate carbon and renewables values (see Table 3) affects the GIC in two ways: energy needs will shrink and fuel switching will occur between fossil fuels and RES. Nevertheless, it is worth noting that the effect on energy consumption prevails on the (rather limited) substitution effect. In total, the GIC decreases by 5% in 2020 in comparison to the *baseline*; it is projected to grow by only 2% between 2005 and 2020. Figure 2 illustrates the impact on the different energy forms. Hardest hit seems to be the consumption of coal that, through the installation of a carbon value, becomes a less attractive energy form for the production of electricity. Oil and natural gas will also decline compared to the *baseline*, although the consumption of natural gas keeps on growing compared to the year 2005. By contrast, a substantial development of renewables takes place (+45% in 2020 compared to *baseline*).

Figure 2: Evolution of gross inland consumption, *baseline* vs. *20/20 target scenario* (Mtoe)

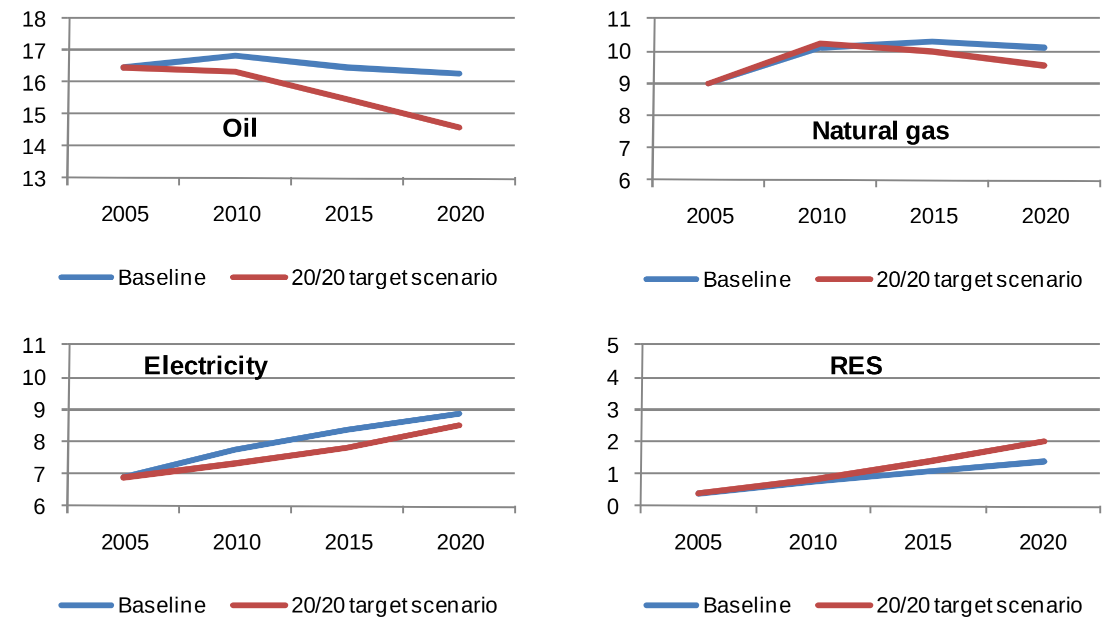


Sources: PRIMES, Bossier et al. (2008).
RES = Renewable Energy Sources.

5.2. Final Energy Demand

With the exception of RES, very few fuel substitutions take place in the final demand sectors. The share of RES attains 12.3% of gross final energy demand in 2020, the deficit with the 13% target being closed by RES flexibility mechanisms. For the sake of comparison, the share of RES amounts to 7.5% in 2020 in the *baseline*. Energy savings take place in all demand sectors. In total, final energy demand decreases by 6% in 2020 in comparison to the *baseline*. More importantly, energy savings concern not only fossil fuels, which experience higher energy prices proportionally to their carbon content, but also electricity (-4% in 2020 compared to *baseline*). This latter evolution differs from results put forward in previous studies dealing only with the effect of a constraint on GHG emissions. Indeed, most of these studies show higher growth rate for the demand of electricity than in a *baseline* projection (see section 6). Figure 3 shows the most relevant impact of the E/C package on final energy demand.

Figure 3: Evolution of final energy demand, *baseline* vs. *20/20 target scenario* (Mtoe)



Sources: PRIMES, Bossier et al. (2008).
RES = Renewable Energy Sources.

Oil savings take the lead both in relative and absolute terms: the demand for petroleum products drops by 11% in 2020 in comparison to the *baseline*. Savings take place in all final demand sectors: -13% in industry, -15% in the residential and tertiary sectors and -8% in transport. In transport, oil savings result from a slight decrease in transport activity (both passenger and freight), improvement of the energy efficiency of vehicles and further penetration of biofuels. Electric vehicles develop marginally at the horizon of 2020 (see infra).

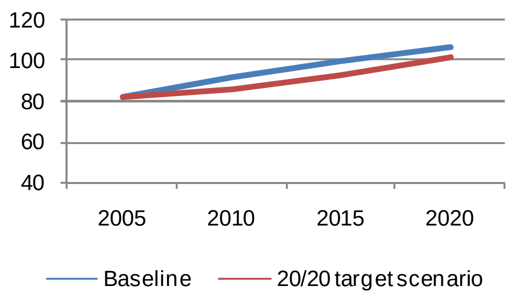
The demand for natural gas is projected to be 6% lower in 2020 than in the *baseline*. This is the result of opposite trends: an increased demand in industry of almost 9% and a lower consumption in the residential and tertiary sectors of about 13% in 2020 compared to the level in the *baseline*.

The twin target leads also to electricity savings. Electricity consumption in industry and in the residential/tertiary sector decreases by 6% and 4% respectively in 2020 in comparison to the *baseline*. On the other hand, the demand for electricity goes up in transport (+17% in 2020 compared to the *baseline*) but the additional consumption is tiny: it represents no more than 0.3% of total electricity demand in 2020.

5.3. Power generation

The power generation also bears the influence of the E/C package. As stressed in the above section, a first reaction of the system is to lower energy demand, including electricity consumption (basically because of the rise in production costs). Net electricity generation stands 5% below the level in the *baseline* in 2020, or the rate of increase in power generation between 2005 and 2020 is 24% in the *20/20 target scenario*, compared to 30% in the *baseline* (see Figure 4[15]).

Figure 4: Evolution of power generation, *baseline* vs. *20/20 target scenario* (TWh)



Sources: PRIMES, Bossier et al. (2008).

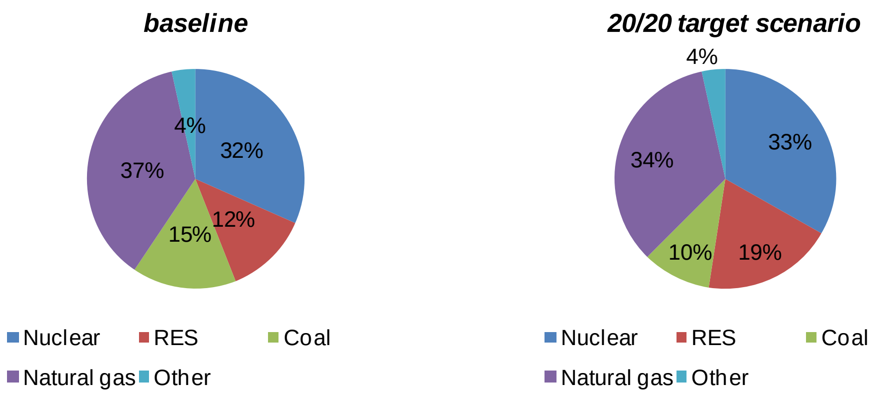
Next, the power mix changes due to substitutions arising from a higher carbon value in the ETS sector[16] and the renewables value: the shares of coal and gas decrease noticeably (respectively from 15 to 10% and from 37 to 34% - see Figure 5), whilst the renewables' based electricity is able to expand its part to 19% (up from 12% in the *baseline*). Net RES electricity production reaches 19.5 TWh in 2020 (+48% compared to *baseline*) which is almost equally allocated between wind and biomass and waste[17].

15 The evolution of power generation is similar to the evolution of final electricity demand (see Figure 3) because the net electricity import was assumed to be the same in both scenarios.

16 The power sector belongs to the sectors submitted to the ETS.

17 Hydro and solar photovoltaic represent less than 1% of RES electricity production.

Figure 5: Net electricity generation in 2020 (%), *baseline* vs. *20/20 target scenario*,



Sources: PRIMES, Bossier et al. (2008).
'Other' stands for oil and derived gases.

5.4. GHG emission trends

All in all, the *20/20 target scenario* leads to a domestic reduction of GHG emissions by 0.5% in 2020 compared to 2005. From *baseline* levels in 2020 however, GHG emissions in Belgium are expected to be 12% lower.

5.5. (Net) energy import

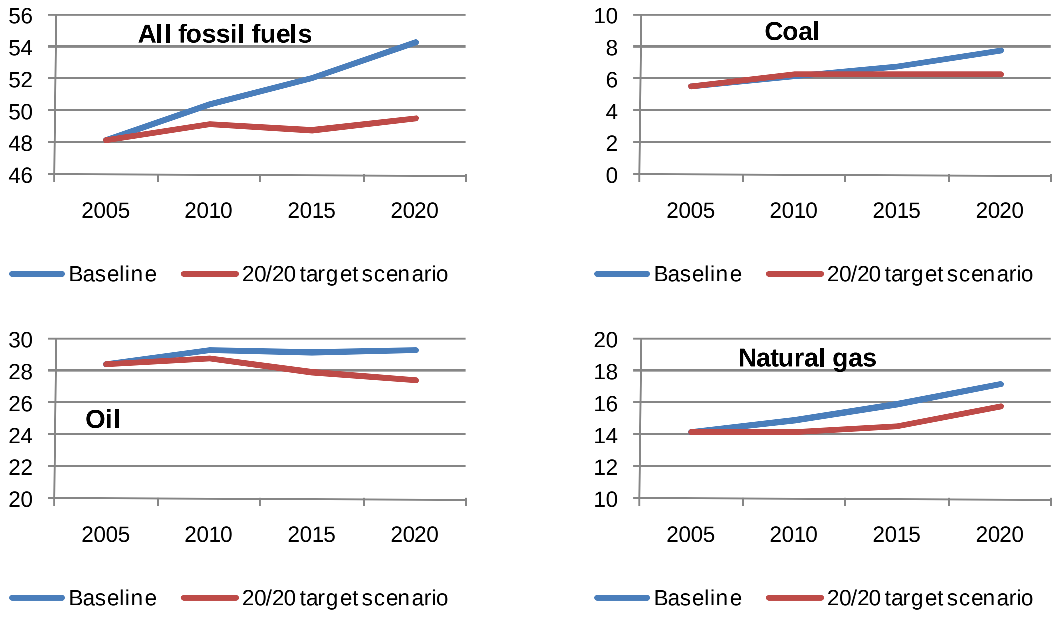
5.5.1. Fossil fuel import

Previous sections have shown that the twin target induces a remarkable boost in the development of RES and fosters energy savings. Both effects lead to a reduction of imports of all fossil fuels relative to the *baseline*. For that reason, the E/C package seems to prevent the security of future Belgian energy supply from deteriorating. In the *20/20 target scenario*, net imports of fossil fuels decrease by 9% in 2020 compared to the *baseline* and increase only slightly by 3% between 2005 and 2020 (see Figure 6).

The growth of natural gas imports is limited to 11% over the same period, compared to 21% in the *baseline*. Coal imports are projected to increase by 15% against 41% in the *baseline*. Last but not least, oil imports in 2020 will be below the level of 2005 (-4%) while they were expected to grow by 3% over 2005-2020 in the *baseline*.

In monetary terms, the reduction in gas imports translates into a saving of about 400 million € in 2020 compared to the *baseline*; for oil, this boils down to a relative saving of approximately 700 million € whilst for coal, 125 million € can be saved by lowering import needs. Together, 1.2 billion € should be gained by a reduction relative to the *baseline* in the consumption of fossil fuels further to the implementation of the E/C package.

Figure 6: Evolution of fossil fuel imports, *baseline* vs. *20/20 target scenario* (Mtoe)



Sources: PRIMES, Bossier et al. (2008).

5.5.2. Biomass import

Although energy imports do shrink considerably, there is one category of import that withstands the pressure: renewable energy sources, in casu biomass. This category, being mainly composed of wood, wood waste, ethanol and rapeseed, expands rapidly. A total of 4.1 Mtoe of biomass and waste will be necessary by 2020 to comply with the twin target. Following the literature on the matter (Bossier et al., 2008, J. De Ruyck, 2006, EEA, 2006, GEMIX, 2009), one third to one half (between 1.6 and 2.3 Mtoe) could be produced domestically, the balance (between 1.8 and 2.5 Mtoe) will then have to be imported[18]. Although engaging in significant biomass imports may provoke all kinds of considerations (see GEMIX, annex 3), in what follows, we assume this amount of biomass import and put it in perspective with the decrease in import volumes of coal, oil and natural gas.

Working with band widths to take the uncertainty surrounding the future biomass prices into account, an interval of 200 to 380 million €[19] could be spent in order to acquire the needed amounts of biomass from abroad. When this amount is compared to the total that could be saved due to reduced coal, oil and gas imports, a ‘net energy import gain’ between 0.83 and 1 billion € can be envisaged. However, this net gain is more than counterbalanced by the additional costs induced by the E/C package: the package’s total direct cost turns out to be 3.5 billion € in 2020 or 0.86% of the 2020 Belgian GDP (Bossier et al., 2008).

18 These figures are coherent with the sum of the figures stated in VITO (2009) and the PMDE (2009).

19 On top of biomass import costs in the baseline.

Box: Impact of the governmental decision of October 2009 on the extension the operational lifetime of the three oldest nuclear power plants (Doel 1, Doel 2 and Tihange 1) on the imports of fossil fuels

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 decided 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, will see their operational lifetime extended with another 10 years. No decision on the newest reactors was taken, so all things being equal, the entire nuclear power production park (5825 MW) will close its doors between 2022 and 2025, the last nuclear kWh being generated in 2025.

Reactors	Model	Net MWe	First power	40-year licence	2009 extension
Doel1	PWR	392,5	1974	2014	2025
Doel2	PWR	433	1975	2015	2025
Doel3	PWR	1006	1982	2022	
Doel4	PWR	1008	1985	2025	
Tihange1	PWR	962	1975	2015	2025
Tihange2	PWR	1008	1982	2022	
Tihange3	PWR	1015	1985	2025	
Total (7)		5825			

Source: FOD Economie & FPB (2009)

Prolonging the operational lifetime of the three oldest nuclear power plants has without doubt a major impact on the structure of the national electricity production park. Not only will 1800 MW continue to be available to fill the energy needs for ten more years to come, but also will these power plants 'replace' fossil fuel plants. Pro memoram: the nuclear lifetime extension will not affect the construction of newly built renewable energy based power plants (Bossier et al., 2008, GEMIX, 2009) since nuclear and renewable energy sources are not fishing in the same load management pond. On top of that, the binding 13% renewable energy objective has to be honoured, with or without the presence of nuclear energy.

According to our calculations, the prolongation of nuclear operation under the E/C package should, by 2020, replace no less than 2500 GWh of coal based electricity and 7400 GWh of natural gas based electricity. This means that the import of 0.4 Mtoe coal and 1.1 Mtoe natural gas for the production of electricity and heat could be avoided by postponing the retirement of the three oldest nuclear power plants.

In monetary terms, this reduction in fossil fuel imports boils down to 330 million € saved in 2020 (respectively 40 million € for dwindling coal imports and 290 million € for natural gas). This figure may not be mistaken for the financial gain of the electric system due to nuclear prolongation. It has to be put next to the imports of uranium and the rejuvenation investments undeniably linked to lifetime extension, amongst other considerations.

6. Twin GHG/RES target vs. pure GHG target: different impacts on energy imports

Above results bring to the fore that, in Belgium, when a double target is imposed (RES and GHG), both total demand and imports of all fossil fuels, including natural gas, decrease compared to the *baseline* trend in 2020. More specifically, the double target prevents gas demand from increasing as a substitute for coal in the power sector and avoids a dramatic drop in coal-based electricity generation because the presence of a renewables value implies a lower carbon price (compared to those required with a single GHG target) to achieve the same level of GHG emission reduction.

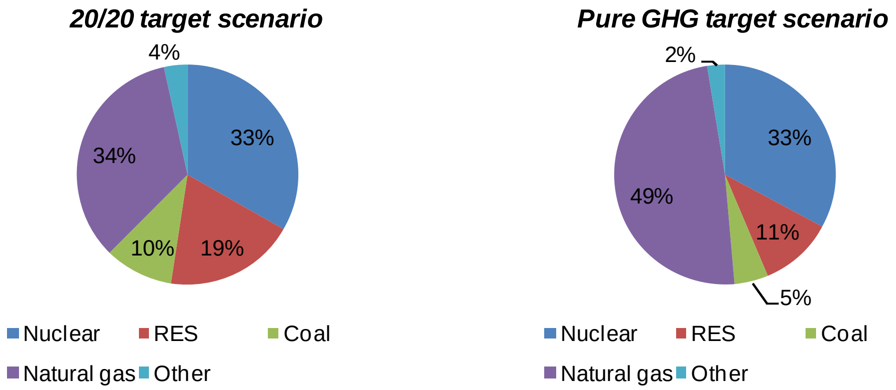
This finding takes the edge off the possible adverse effects that climate change actions may have on gas import dependence and, hence, on the energy security of a country whose power sector will have to progressively decommission its nuclear power plants. These adverse effects were put forward in previous studies dealing only with the impact of a constraint on GHG emissions. Indeed, most of these studies showed a significant penetration of natural gas in power generation and concluded to the particular vulnerability of the Belgian energy system vis-à-vis natural gas imports.

To illustrate the above statement, we refer to a study realised in 2006 (FPB, 2006) because it provides a scenario where the GHG reduction effort required between 2005 and 2020 is similar to the one computed in the *20/20 target scenario*. For the sake of simplicity, this scenario will be refered to in the following as *Pure GHG target scenario*. Notwithstanding this common denominator, the two scenario are not strictly comparable as they rely on different assumptions as to e.g. the development of fossil fuel prices[20]. The analysis below is therefore mainly illustrative and fills the gap of a pure GHG target scenario lacking in Bossier et al. (2008).

To begin the comparison, Figure 7 shows the fuel mix in the power sector in 2020 in both scenarios (*20/20 target scenario* and *Pure GHG target scenario*).

20 This is illustrated in Figure 8 which shows the different trends in power generation in the *baseline* scenarios of both studies.

Figure 7: Net electricity generation (%), twin GHG/RES target vs. pure GHG target, year 2020

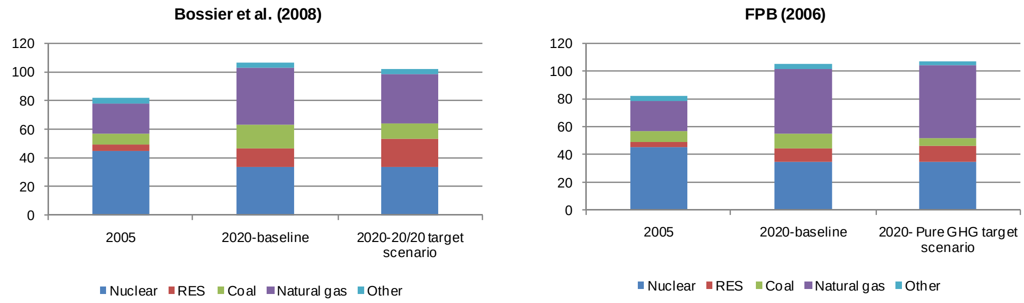


Sources: PRIMES, Bossier et al. (2008), FPB (2006).
'Other' stands for oil and derived gases.

A first conclusion that can be drawn is that the twin GHG/RES target leads to a more balanced fuel mix in 2020 than a pure GHG target. In the *20/20 target scenario*, natural gas and nuclear energy each cover slightly more than 30% of the Belgian electricity production whereas the share of coal remains close to its share in 2005 (i.e. 10%). On the other hand, the share of green electricity is pushed forward by the renewables value; it represents almost one fifth of total power generation. In the *Pure GHG target scenario*, however, gas-based power generation dominates the fuel mix (almost 50%) and coal and RES together cover less than one fifth of total power generation. The carbon value required to meet the GHG reduction target is higher than in the *20/20 target scenario* (above 40 €/t CO_2) and prevents coal, the fuel with the highest carbon content, to preserve its market share; it is however not able to incite a strong deployment of RES.

Another difference between the two approaches concerns the demand for electricity (hence, the level of power generation). While electricity consumption decreases in the *20/20 target scenario* compared to the *baseline* in 2020 (-5%), it goes up in the *Pure GHG target scenario* compared to its *baseline* (+2%).

Figure 8: Power generation, twin GHG/RES target vs. pure GHG target, years 2005 and 2020 (TWh)



Sources: PRIMES, Bossier et al. (2008), FPB (2006).
'Other' stands for oil and derived gases.

The increased share of natural gas in power generation combined with the growth in electricity demand (compared to *baseline*) results in higher natural gas consumption in the power sector that is not fully compensated by natural gas savings in the final demand sectors. The net effect is a growth in natural gas imports in the *Pure GHG target scenario* in 2020 compared to the *baseline*. Natural gas imports are 2% above the *baseline* level in 2020, compared to 9% below the *baseline* level in the *20/20 target scenario*.

The above analysis shows that concerns about the security of Belgian energy supply, and in particular of natural gas supply, could be watered down in 2020 by the twin GHG/RES target.

7. Conclusions

In June 2009, the EU Energy/Climate legislative package entered into force. This package steps up the European Union's energy and climate policy ambitions to a new level and outlines how the effort will be shared among the Member States. One key element of the E/C package is the installation of a twin target for the year 2020: a reduction target for EU greenhouse gas emissions on the one hand, a development target for renewable energy sources in the EU on the other. These two targets influence one another (i.e. the former helps to achieve the latter and vice versa) and bring along both costs and benefits.

One of the benefits of combining a GHG with a RES target is the improvement in energy supply security through reducing energy imports. Improving the security of energy supply is particularly important in a country like Belgium given that the Belgian soil does not contain any fossil fuel resource, that no new nuclear power plants can be constructed, that the operational lifetime of existing nuclear power plants is limited in time and that the potential of renewable energy sources is to a certain extent relatively limited.

Main outcomes of the installation of the package then are the substitution in favour of carbon free resources (i.e. res) and the decrease in energy demand including the demand for electricity, which in turn not only lead to reduced overall fossil fuel imports relative to baseline, but also water down the trend towards an increased dependency on natural gas imports.

In 2020, following the E/C package, Belgian imports of natural gas can be diminished by 400 million € relative to the baseline, of coal by 120 million € and of oil by 700 million €, this all summing up to a total saving of 1.2 billion € compared to the baseline. On the other hand, the package necessitates the deployment of large amounts of biomass, part of which have to come from across our borders. Import of biomass is then estimated to be between 1.8 and 2.5 Mtoe in 2020, representing a supplementary monetary cost (on top of baseline biomass import cost) of between 200 and 380 million €. This tilts the import balance to a net gain of 0.83 to 1 billion € in 2020.

Extending the operational lifetime of the three oldest nuclear power plants also has an impact on the import picture: in 2020, a further 330 million € could be saved at the import side by avoiding fossil fuel based power generation.

This positive picture, however, characterizes in particular the time frame up to 2020. In the longer term, things might look different: government's recent decision on nuclear leading to a full phase out of all nuclear power capacity by 2025 will most likely translate into higher fossil fuel imports from 2025 on despite climate change and renewables' policies in the pipeline, back-up capacity needed in a gradually decentralised power system relying more and more on intermittent energy sources should also put more stress on natural gas supply, ... Belgium might then be up against severe problems in terms of energy supply security. Nevertheless, even in the longer term, the E/C package and its potential successor(s) will play their role of reducing our dependence on fossil fuel imports via improvements in energy efficiency and further deployment of RES.

8. Annex: Some figures

Table 4: Some figures for the years 2005 and 2020, *baseline* vs. *20/20 target scenario*

	2005	2020	
		Baseline	20/20 target scenario
Gross inland consumption (Mtoe)	55.0	59.2	56.0
Coal	5.4	7.8	6.4
Oil	20.5	20.8	18.9
Natural gas	14.1	17.2	15.8
RES	2.0	3.7	5.4
Final energy demand (Mtoe)	36.3	41.4	39.0
Coal	2.1	2.7	2.5
Oil (petroleum products)	16.4	16.3	14.6
Natural gas	9.0	10.1	9.6
Electricity	6.9	8.9	8.5
RES	0.4	1.4	2.0
Net power generation (TWh)	82.1	106.6	101.7
Net imports (Mtoe)			
All fossil fuels	48.1	54.4	49.5
of which			
Coal	5.5	7.8	6.4
Oil	28.4	29.3	27.4
Natural gas	14.2	17.2	15.8
Biomass (*)	0.3	[0.8-1.5]	[1.8-2.5]

Source: PRIMES, Eurostat.

(*): 2020 figures are not model results but estimates based on literature (cfr. section 4.5.2 and 5.5.2).

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