GLOBAL SCENARIOS FOR SOCIO-ECOLOGICAL TRANSITION

BOITIER BAPTISTE, LANCESSEUR NICOLAS, ZAGAMÉ PAUL

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Abstract: This paper aims to deliver a quantitative description of the two global context scenarios for EU based on the qualitative scenarios developed in the NEUJOBS FP7 project. These scenarios are defined by two sets of "global megatrends" which have two main axes: natural (e.g. energy prices) and societal (e.g. demographic dynamics). The objective is to provide some quantitative socio-economic and environmental results to reveal the main challenges for EU in the framework of the "socio-ecological transition" without policy intervention and according to the global context. These results will also serve as references to assess the policies proposed to tackle the difficulties identified in this paper. Our results emphasise that none of the economic and employment objectives of the "Europe 2020" strategy while only few European environmental objectives will be reached in the event of a lack of policy responses to the SET. In particular, in one of the scenarios, the unfavourable European demographic and natural conditions do not allow for the release of the sovereign debt burden. The necessary fiscal consolidation induces then a weak economic growth and a high unemployment rate up to 2030. Thus, in that framework, investments enhancing the adaptation to the SET would not be possible. Besides, even in the more favourable scenario, the strong increase in high-skilled labour supply brings about a "bottleneck effect". The labour demand does not totally absorb this boom of high-skilled labour supply. Therefore, policies such as tackling innovation, research or competitiveness can facilitate to overcome employment and environmental difficulties. However, structural policies for resource efficiency and climate change (e.g. carbon price, energy-saving investments supports or rising of environmental standards) will also be necessary to smooth the path towards a successful socio-ecological transition.

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Global scenarios for European socio-ecological transition

Baptiste BOITIER[*], Nicolas Lancesseur[†], Paul Zagamé[‡]

[*]Ecole Centrale Paris & SEURECO, Corresponding author: SEURECO, 9 rue de Chateaudun 75009 Paris, FRANCE, email:baptiste.boitier"at"erasme-team.eu

[†]SEURECO & Université de Paris 1

[‡]SEURECO

Abstract

This paper aims to deliver a quantitative description of the two global context scenarios for EU based on the qualitative scenarios developed in the NEUJOBS FP7 project. These scenarios are defined by two sets of "global megatrends" which have two main axes: natural (*e.g.* energy prices) and societal (*e.g.* demographic dynamics). The objective is to provide some quantitative socio-economic and environmental results to reveal the main challenges for EU in the framework of the "socio-ecological transition" without policy intervention and according to the global context. These results will also serve as references to assess the policies proposed to tackle the difficulties identified in this paper. Our results emphasise that none of the economic and employment objectives of the "Europe 2020" strategy while only few European environmental objectives will be reached in the event of a lack of policy responses to the SET. In particular, in one of the scenarios, the unfavourable European demographic and natural conditions do not allow for the release of the sovereign debt burden. The necessary fiscal consolidation induces then a weak economic growth and a high unemployment rate up to 2030. Thus, in that framework, investments enhancing the adaptation to the SET would not be possible. Besides, even in the more favourable scenario, the strong increase in high-skilled labour supply brings about a "bottleneck effect". The labour demand does not totally absorb this boom of high-skilled labour supply. Therefore, policies such as tackling innovation, research or competitiveness can facilitate to overcome employment and environmental difficulties. However, structural policies for resource efficiency and climate change (*e.g.* carbon price, energy-saving investments supports or rising of environmental standards) will also be necessary to smooth the path towards a successful socio-ecological transition.

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Executive summary

This paper aims to deliver a quantitative description of the two global context scenarios ("Friendly" and "Tough") for EU based on the qualitative scenarios developed in the NEUJOBS FP7 project. These scenarios are defined by two sets of "global megatrends" which have two main axes: natural (*e.g.* energy prices) and societal (*e.g.* demographic dynamics).

European economy is expected to recover from the sovereign debt crisis up to 2015, even if public finance imbalances could impact economic growth after 2015. In the "Friendly" scenario where high-skilled labour supply is increasing significantly, European economic growth gets closer to its high long-term potential. Therefore, regarding long-term economic growth between members states, there is a significant heterogeneity. In the "Friendly" scenario, this heterogeneity could be largely explained by the difference of labour force evolution between EU countries. In the "Tough" scenario, the growth of labour force is expected to be lower in quantity as well as in quality than in the "Friendly" scenario and raw materials prices (including energy), exchange rates and interest rates are expected to be higher, leading to a lower long-term GDP growth potential. Regarding the level of public debt in numerous European countries, this lower GDP potential does not allow governments to rebalance their finances. With this in mind, general governments have to reduce public expenditures, so fiscal consolidation enables the return to deficit equilibrium. Finally, the depressive effects of this consolidation imply a significantly lower European GDP growth rate in the "Tough" scenario compared to the "Friendly" one after 2015, even if this budgerary efforts will enhance long-term economic growth by relaxing sovereign debt burden.

Employment evolution in both scenarios presents large differences but also some likeness. In absolute terms, the "Friendly" scenario creates almost 20 million jobs between 2010 and 2030. Most of these new jobs are created in services, mainly private but also non-market after the public finance strengthening. This process of 'tertiarisation'- shift towards service sectors - of European economy is in line with past trends but occurs at a lesser extent. The development of services comes with a slower outsourcing of tertiary tasks in industry, a higher exposition of services to offshoring and a rise of services productivity thanks to ICT development. These factors slow the tertiary expansion compared to past figures. However, the share of services employment in the "Friendly" scenario passes from 70% to 75% in two decades. In the "Tough" scenario, the figures are very different. Total employment diminishes by almost 7 million between 2010 and 2030. Non-market services are strongly affected by the rigorous budgetary policy in EU. And private services which constitute the engine of European economic growth in the "Friendly" scenario, do not find its own growth engine in European internal market. Thus, less than half new jobs in services created in the "Friendly" scenario are not created in the "Tough" one. The "Tough" scenario can be considered as a wasted opportunities scenario. However, both scenarios are characterised by a 'skillisation' in all European sectors and by an unappeasable process of low-skilled job destruction. Indeed, the share of high-skilled employment reaches 36% in the "Friendly" scenario, 30% in the "Tough" while it was about 25% in 2010. European economic growth, despite a different intensity between scenarios, comes from a strong increase in high-skilled jobs. Nevertheless, some bottlenecks may occur leading to a raise of high-skilled workers unemployment in some European sectors if strong socio-ecological transition support policies are not implemented. These results plead for innovation and educational policies.

The scenarios are strongly differentiated by the pathways of energy efficiency. The "Friendly" scenario exhibits already large energy efficiency gains that allow a decoupling between economic growth and primary energy consumption. Therefore, this scenario leads the way of the energy transition, thanks to first energy-saving investments and then a better environmental awareness of European citizens (mainly due to higher energy prices). In the "Tough" scenario, energy efficiency remains weak (in line with past trends). So even with weaker economic growth and higher energy prices, energy consumption in the "Tough" scenario is higher than in the "Friendly" scenario. Thus, the "Tough" scenario is not engaged in the energy transition. The short-term European target of -20% of GHG emissions in 2020 compared to 1990, is achieved in both scenarios. But regarding more long-term objectives (in particular the 2030 milestone of the Roadmap), it remains important efforts for European countries to follow the reduction pathway compatible with the target of climate change below 2°C. Nevertheless, the effort will be easier in the "Friendly" scenario than in the "Tough" insomuch as the former scenario has already made a step towards socio-ecological transition.

Even if some "Europe 2020" objectives are achieved in both scenarios, most of them are not. Three kinds of policy could be adapted to tackle these difficulties. On the one hand, financial reforms would help the EU break free from financial constraints and to encourage European economic growth, although the "Tough" scenario shows that a too strong financial consolidation combined with unfavourable demographic and natural conditions would induce both lasting weak economic growth and high unemployment. On the second hand, innovation, research or competitiveness policies can tackle both employment and environmental difficulties encountered in the reference scenarios. For instance, the relatively high-skilled unemployment rate may be reduced by these new policies. The increase of intangible capital (economic competencies, ICT, organisational capital, etc.) should also come together with support policies for innovation and research. Finally, structural policies for resource efficiency and climate change (*e.g.* carbon tax, energy-saving investments supports or rising of environmental standards) are necessary for the pathway towards a successful socio-ecological transition.

1 Introduction

This paper aims to deliver a quantitative assessment of two global context scenarios based on the qualitative scenarios developed by Fischer-Kolwalski *et al.* (2012, [31]). These scenarios are characterised by two sets of "global megatrends" which have two main axes *(i)* megatrends in natural conditions and *(ii)* societal megatrends. Beyond the characterisation of these megatrends, the two scenarios have been designed in order to define two different global contexts in which the Socio-Ecological Transition (SET) will take place. The socio-ecological transition has been defined by Fischer-Kolwalski *et al.* (2012) as *"transitions between socio-metabolic regimes"* which are *"regime(s) [...] rooted in the energy system a society depends upon, that is the sources and dominant conversion technologies of energy"*[1]. Nevertheless, at this step, the purpose of the two references scenarios is not to provide evidence on how the transition will take place. The aim is to give the global analytical context in which the socio-ecological transition will operate. Thereafter, they will allow the assessment of the European policies response in two very different contexts, challenging for Europe.

These two sets of megatrends for both reference scenarios will be implemented in a coherent quantitative framework, based on modelling and accounting. Besides the interest of giving figures for economists, stake-holders and policy makers, these quantitative scenarios will allow for the illustration of the opportunities, risks and challenges associated to socio-ecological transition in Europe.

1.1 The methodology

The model based methodology, if it allows the quantification, in a coherent framework, of sustainability indicators, encounters nevertheless two main difficulties. Firstly, it requires a quantification of the natural conditions megatrends such as energy, natural resources or climate change and societal megatrends like population dynamics, shifting of economic and political power, etc. Secondly, the modelling of severe changes, as described in the storylines, still remains difficult without model modifications. Regarding this difficulty and in order to avoid the confusion between global context scenarios and EU policy response scenarios, the model mechanisms have been kept in the state of the art.

Thereafter, policies that will try to tackle the difficulties and challenges identified in the two different global contexts will be discussed. Two sets of policy families will be explored *(i)* market instruments policy (economic incentives, taxation, etc.) and *(ii)* policies on governance, education and societal changes.

Practically the first exercise is a quantification, at the European level, of the megatrends identified by Fisher-Kowalski *et al.* (2012 [31]) at the global level. These drivers will thereafter be introduced in the NEMESIS model[2] to deliver two detailed pictures of the European economy up to 2030. The interest of using such a model lies in three main characteristics:

[1] See Fischer-Kowalski and Haberl (2007 [32]) from detailed definitions of socio-metabolic regimes.

[2] See *e.g.* Zagamé *et al.* (2010, [57]) or Boitier *et al.* (2012, [5]) for details on the NEMESIS model or http://goo.gl/5dJ9c.

- NEMESIS is a detailed macro-sectorial and econometric model which is, by its kind, fundamentally different from an optimizing one. Thus, projections do not necessarily lead to long-term general equilibrium. An analysis of market disequilibrium like unemployment can provide more relevant views than an analysis within a general equilibrium framework. Furthermore, behavioural equations can be easily modified (with the support of experts) enabling, for instance, the implementation of governance or educational policies.

- NEMESIS integrates an energy and environment module capable of projecting energy consumption and greenhouse gases (GHG) emissions especially CO_2 emissions.

- NEMESIS can describe the endogenous technical change process[3]. Thus, it gives a better understanding of the productivity and potential growth evolution, and enables the assessment of numerous structural policies (*e.g.* climate change mitigation or resource efficiency policies) with regards to R&D and innovation.

1.2 The reference scenarios

In the socio-ecological transition framework, the two global reference scenarios have been differentiated regarding the global megatrends. Thus, in the first scenario called "Friendly", the global conditions for a better socio-ecological transition are gathered. The natural constraints relative to raw materials are rather strong at the beginning, but economic activity is oriented towards more sustainability and resource efficiency, reducing the long-term pressure on raw materials. Besides, the European economies overcome the financial crisis and return to a relatively high economic development, facilitated by an increase in quantity and in the qualification of workers.

On the contrary, socio-economic and environmental risks slowing down the socio-ecological transition are gathered in the second scenario called "Tough". In this scenario, the economic development is slowed down mainly by a declining labour force and also increasing trends in raw material and energy prices. Those unfavourable conditions reduce potential economic growth and then financial leeway to repay public debt. It leads financial markets to raise their risk premium for the EU countries. This domino effect increases the difficulties of EU public finance and it reinforces the depressive effect. In this context, the investments necessary for a succesful socio ecological transition are frozen and then European countries will encounter major difficulties.

1.3 Content

This paper is structured around five sections. The first introduces the two global scenarios "Friendly" and "Tough" in the context of the socio-ecological transition. It presents the global assumptions surrounding both scenarios and it goes beyond global aspects to look at specific scenario assumptions for the European Union. The second section displays the economic projections resulting from the implementation of both scenarios within the NEMESIS model and it details and explains the drivers

[3]See Brécard *et al.* (2006, [6]) or Chevallier *et al.* (2006, [14]) for a detailed description of the NEMESIS endogenous technical change module and for applications.

of the results and provides a detailed presentation of the labour market projections up to 2030. The third section focuses on the main drivers of new jobs creation. The fourth part emphasises energy and environment projections for the European Union, looking at energy consumption and Greenhouse Gases (GHG) emissions. Finally, the fifth section contextualises the previous results regarding the European policies challenges relative to the socio-ecological transition and provides a critical view of the projections compared to other studies.

2 Two global contexts

2.1 Global socio-ecological transition context

First, it is important to define the context of "socio-ecological transition". The concept of "socio-ecological regime", developed by Fischer-Kowalski and Haberl (2007 [32]), defines the relationship between a human society and its environment. The main features of this relationship are the sources and the dominant conversion technologies of energy used by the society to satisfy its needs. The first example of socio-ecological transition (SET) is the transition from the "Hunting and gathering" regime, characterized by passive solar energy utilization, to the agrarian regime characterized, on the contrary, by active solar energy utilization, since human activities like agriculture, or livestock farming, implies the transformation of ecosystems. Then, industrial revolution led to a regime based mainly upon fossil fuels and corresponding technologies that deliver power to the system of production.

Now, it is assumed that human society going through a transition to a new regime since the depletion of the fossil fuels stocks and the climate change make the current industrial regime no longer sustainable (*e.g.* Meadows *et al.*, 2004 [47]). In fact, the symbolic end of fossil fuels called «peak oil» might have already happened, in 2008 according to Alekett *et al.* (2010 [1]) or will happen before 2035 (*e.g.* EIA, 2010 [25] or Sorrel *et al.*, 2009 [52]). Besides, the transformation of the earth system caused by current human activities (global warming being the best example) could have catastrophic consequences on the organisation of human societies (*e.g.* IPCC assessments, 1995 [40], 2001 [41] or Stern, 2006 [53]).

The sustainability of the regime is a worldwide challenge but developed countries, hence Europe, should be in the forefront of the new transition. First, they have the best technical abilities to find new sources and new technologies for energy. Moreover, their structural economic situation requires a radical adaptation. Indeed, the rapid economic catching-up of emerging economies puts additional pressure on resources' stock and, given the high degree of openness of contemporary economies, also deeply modifies the sectorial composition of employment (in particular with a positive impact on high-skilled workers but a negative impact on low-skilled workers, *a priori*[4]). Thus, investments relative to the socio-ecological transition could enhance the creation of sustainable jobs in innovative sectors. The ageing and the stagnation of most of developed countries' population is an important feature of the new SET as well, especially in Europe, insofar as, beyond the modification of the consumption structure, it questions the balance of social systems implemented after the Second World War (Hemerijck, 2012 [34], Hemerijck *et al.* 2013 [35]).

2.2 General context assumptions

In this paper, the two reference scenarios are defined and differentiated by two sets of global megatrends (demography, energy prices, external economic growth, interest rates, etc.). In the "Friendly" context, the set of megatrends is chosen so as to make the adaptation to the socio-ecological transition easier for the European Union. At the opposite end, in the "Tough" context, the set of megatrends is supposed

[4]See for instance Moore and Ranjan (2005 [49]).

to make up the worst situation in which Europe would have to make this transition. The role of this "Tough" context is to illustrate the difficulties and the challenges if all the global risks are gathered for Europe during the transition. It also emphasises that a strong and brutal policy response from Europe would be necessary. Thus, these two reference scenarios constitute the two polar cases in the set of the likely European futures up to 2030 without policy response.

The two reference scenarios are differentiated by the external conditions for Europe *(i)* natural conditions: raw materials prices and especially energy prices and *(ii)* economic and financial conditions: exchange rates, interest rates or world demand; and by the dynamics of the population, with larger economic impact of demographic hypothesis than natural conditions. Both scenarios are already well defined by large storylines (see Fisher-Kowalski *et al.*, 2012 [31]). But in order to implement them in a quantitative tool such as the NEMESIS model, it is important to quantify them. Therefore, the quantification of these drivers tries to fit as well as possible with the socio-ecological global context. In addition, special attention was paid to the use of external studies from different experts' fields to quantity the NEMESIS drivers such as for population projections, energy prices, etc[5].

2.3 Specific scenarios assumptions

The following assumptions are the quantitative translation of the natural and societal conditions that define the socio ecological framework. These drivers, exougenously fixed in the model, will influence the macroeconomic and environmental paths for Europe up to 2030. For instance, the trends of the interest rates were determined *ex-ante* to embody the sovereign debt risk.

The "Friendly" scenario: an important qualitative and quantitative increase in labour force, with favourable financial conditions

The demographic scenarios have been designed by Huisman *et al.* (2012 [37]). In the "Friendly" case, the net migration flow (mainly of high-skilled people) is relatively high[6] resulting in an increase in the European population (+18 million *i.e.* +3.5% in two decades) and labour force (+15.5 million and +6.5%). Few exceptions like Germany and Bulgaria face a decrease in their population (respectively -6% and -9%) and labour force (respectively -3.5% and -7%). In addition, beyond a slight growth of the life expectancy, the structure of European population is largely influenced by post-war "baby boom" and by the birth rate fall. It induces an increase of the old age dependency ratio[7] from 25% in 2010 to 34.5% in 2030. The ageing of the European population will therefore induce financing difficulties for social systems without a high level of net migration. It will also modify the consumption patterns which will require an adaptation of the supply.

For the projections of population by level of skill, Huisman *et al.* (2012 [37]) have adopted the methodology developed by KC *et al.* (2010 [43]). In the "Friendly" scenario, each young generation has

[5]This deliverable uses data and assumptions from the NEUJOBS deliverable 10.1 (Huisman *et al.*, 2012 [37]), which was rejected by the EC. This might lead to results that will not be accepted by the European Commission, but the responsability cannot be asigned to SEURECO. The Steering Committee made the decision to make the new results of the deliverable 10.1 only available to the public once the EC has approved the new deliverable. This was not done at the time deliverable 9.2 was written.

[6]See footnote 5.

[7]Ratio between the number of people aged 65 or over and the working age population (15-64).

a higher level of education than the previous one. Thus, all countries have a larger skilled population in 2030 and the European skilled labour force is expected to grow by 76.5% *(i.e.* +35.5 millions) between 2010 and 2030.

World demand driven by economic growth outside Europe is one of the main drivers of the European economic growth through the dynamics of external trade. The projections used for the scenarios are produced by the Conference Board (Chen and Colijn, 2012 [13]), using the growth accounting framework methodology (see Chen *et al.,* 2011 [12]) based on a projection of the economic growth determinants (labour force, capital and technology). Besides, the interest rate is an essential determinant of the investment decision for firms and households (real estate investments) as well as the cost of public deficits[8]. Since the "flight to quality" phenomenon implies that investors increased their demand of government bonds after the financial crisis, the interest rate of bonds relative to many European countries (Germany in particular) stands at historically low levels. It is assumed in the "Friendly" scenario that the European interest rates will increase but will remain rather weak, moreover in the current context of moderate inflation. Besides, the euro/dollar exchange rate is stable in this scenario.

Research and development expenditures are an important driver of the economic performance within the NEMESIS model. Indeed, it is one of the determinants of the total factor productivity and the good demand (via the quality and price effects). In fact, the lack of investment in R&D and innovation[9] and the delay in integrating ICTs in Europe are a common explanation of the growing productivity gap between USA and EU during the last decades (*e.g.* van Ark *et al.* 2008 [55]). Since the Lisbon strategy in 2000, the European Union envisions to fill this gap and therefore EU had fixed a target of 3% of GDP for R&D expenditures for 2010. As these targets were not reached, EU has postponed the target date to 2020 (EC 2011, [20]).

However, given the current financial constraints and since it is assumed no additional policies in the reference scenarios, R&D intensity is supposed to be constant compared to 2010 in both scenarios. Higher objectives could be reached in the future EU response scenarios to enable the enhancement of energy efficiency and general competitiveness. Although R&D intensity is imposed *ex-ante*, innovation process remains endogenous. Each sector has its own knowledge stock which is the combination of the "in-house" R&D stock and knowledge spillovers. The economic performance of the innovation, in particular on the labour market, is thus highly dependent on the share between the R&D expenditures allocated to process innovation and those allocated to product innovation. Indeed, the process innovation leads to productivity gains with unfavourable effects on labour market in the short-term, whereas the product innovation leads to quality product improvements directly favourable to employment (higher demand for the products).

In the "Friendly" scenario, energy prices projection comes from "new policies scenario" of the International Energy Agency (IEA 2011 [38]). In this scenario, the net growth in global oil demand arises from emerging countries especially from the transport sector. Besides, over the past few years, the boom of unconventional gas has pushed down the natural gas price, especially in the USA, but its additional supply is not enough to overcome the additional gas demand coming from energy needs

[8] In the model, the interest rates relative to the national bonds are the drivers of the yield curve on the financial markets.

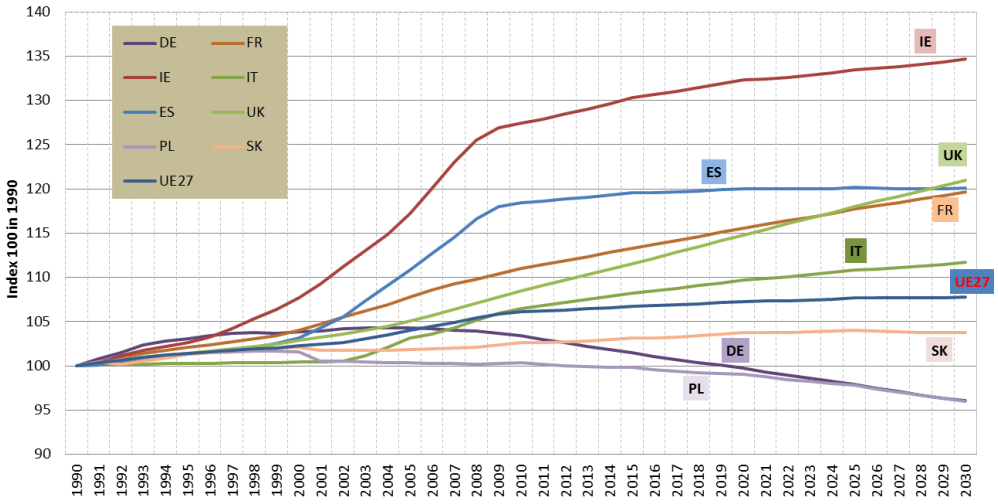
[9] R&D expenditures in Europe is below 2%, compared to 2.6% in the US and 3.4% in Japan.

in emerging countries and substitution to coal in power generation all around the World. Thus, gas price remains relatively high at least for the European Union. So, the important economic growth in the emerging countries will be a driver of the energy prices which are reaching US$11.7/Mbtu for gas and US$117.3/bbl for oil in 2030 (in 2010 constant dollar). In addition, the projected coal price is not increasing as rapidly as oil and gas prices. It reaches US$109.3/t in 2030.

The "Tough" scenario

In the tough environment without policy response, the strong change in the megatrends would cause serious damages in the European-Union. In particular, the migration flow is weaker than in the "Friendly" leading to a slight increase of the European population (+1.5% and +8 million in 2030 compared to 2010, see figure 2.1[10]) and a slight decrease of the labour force (-1% and -2 million). Furthermore, life expectancies rise will be higher[11] in this scenario inducing a substantial increase of the old age dependency ratio compared to the friendly case (see figure 2.2) As an example, the ratio raises from 31% in 2010 to 50% in 2030 in Germany.

Figure 2.1: Population evolution in the "Tough" scenario (base 100 in 1990)



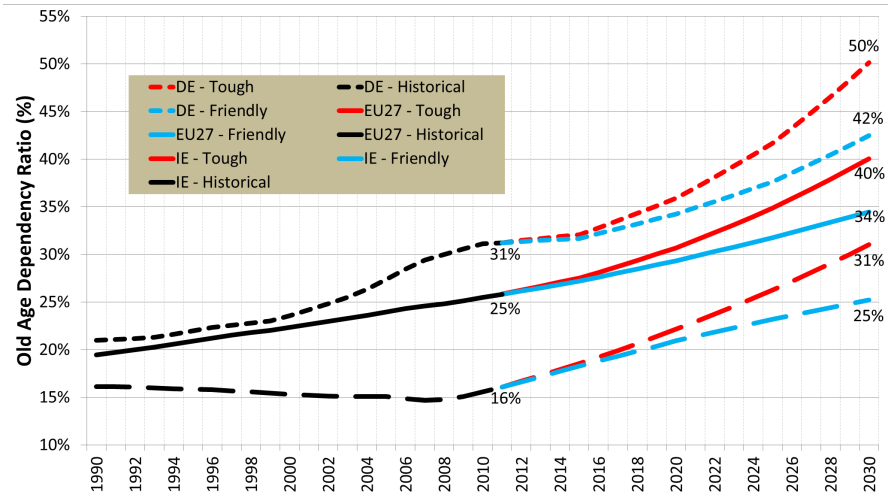
Source: Historical data (Eurostat, 2012 [30]), Huisman *et al.* (2012 [37]) and authors calculation

Huisman *et al.* (2012 [37]) assumed in the "Tough" scenario a constant level of education attainment within each cohort. Consequently, the European population educational level is globally stable despite some heterogeneous dynamics between the different members' states. It grows substantially in particular in France and Italy with respectively an increase of 38.6% and 35.4% between 2010 and 2030, while it decreases by 5% in Germany during the same period (figure 2.3). The "Tough" context is more challenging insofar as labour productivity is partially determined by the level of education.

[10] See Appendix for EU countries abbreviation.
[11] See footnote 5.

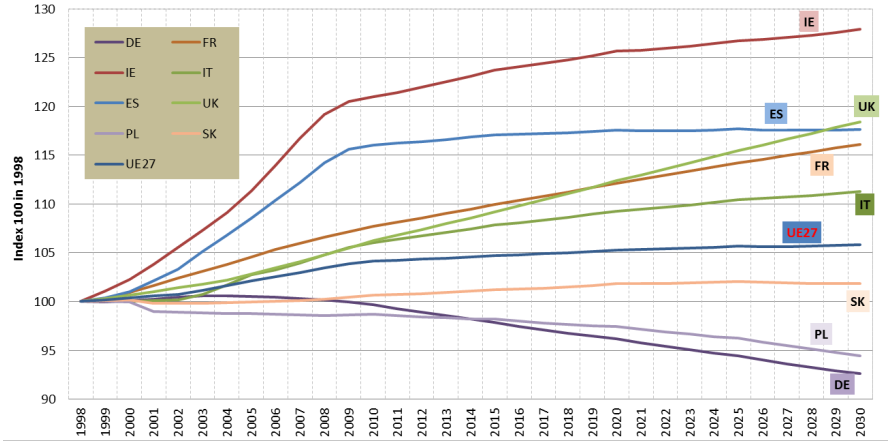
Thus labour productivity should be lower in the "Tough" scenario.

Figure 2.2: Old age dependency ratio



Source: Historical data (Eurostat, 2012 [30]), Huisman *et al.,* 2012 [37]) and authors calculation

Figure 2.3: Skilled population evolution in the "Tough" scenario (base 100 in 1998)



Source: Historical data (Eurostat, 2012 [30]), Huisman *et al.,* 2012 [37]) and authors calculation

The weaker population growth in the "Tough" case leads to lower economic growth rate in mature economies, while emerging countries have a relatively stronger economic growth. In this framework, the tough environment is highly challenging for Europe insofar as the weak economic growth in advanced economies reduces opportunities for external trade although the relatively high growth rate of emerging countries maintains a strong pressure on the raw materials prices, especially energy prices. These economic dynamics accelerate the shifting of the world economic and political centre of gravity. This last point is a common view among economists, hence for Fouré *et al.* (2012 [33]), China could represent

33% of the world economy in 2050 (against 10% in 2010) while the United States share would drop from 25% in 2008 to 9% in 2050.

In the "Tough" scenario, the "savings glut" mainly due to emerging economies should be attenuated. In particular, Chinese savings will be shifted toward domestic demand, thanks to the rising middle class. It will accelerate the shift of the economic and political centres of gravity toward the emerging countries. Besides, the higher ageing rate implies a growing shortage of savings (life-cycle hypothesis - Ando and Modigliani, 1963 [2]) and then a rise of the cost of capital to restore the balance. Both last factors imply that the "Tough" context is a context of a depletion of the capital supply and then of a rise of the interest rates. Finally, the likely improvement of the financial regulation would slightly push up the capital cost (Levine *et al.,* 2003 [16]). Therefore, the interest rates will increase to a more "normal" level in this scenario. This increase of the European interest rate must be considered in a general increase of the "world" interest rate (so this is possible that the European rate decreases relatively to the "world" one). It could also be merely considered as a higher risk premium in a tough environment[12]. This reflects the rise in the credit constraints for firms and households and therefore the shrinkage of investment goods demand. Moreover, higher interest rates increase government debt burden which means less government spending[13]. Besides, Euro/US dollar exchange rate is assumed to be higher in the "Tough" scenario. The Euro exchange rate is both a determinant of the competitiveness of European products on foreign markets and a determinant of the price of foreign goods on the European markets.

Finally, the combination of *(i)* a relatively important economic growth in the emerging economies and *(ii)* an insufficient oil supply increases the stress on energy markets and especially on the oil market. Thus, all energy prices are supposed to be high in the "Tough" scenario with the oil price reaching US$195/bbl in 2030.

The table 2.1 summarises the main evolution of the quantitative drivers.

Table 2.1: Summary of quantitative assumptions (change between 2010 and 2030)

		Friendly	Tough
Societal	Demography (million)	+18M	+8M
	Old age dependency ratio (%)	25% to 34.5%	25% to 40%
	Labor force (million)	+15.5M	-2M
	- High-skilled	+35.5M	+15.5M
	- Low-skilled	-20M	-17.5M
Energy prices	Oil price ($US'10/bbl)	$78 to $117	$78 to $195
	European gas price ($US'10/Mbtu)	$7.5 to $11.7	$7.5 to $12.6
	European coal price ($US'10/t)	$99.2 to $109.3	$99.2 to $115.9
Financial	European rate of interest (%)*	3.6 to 4.4	3.6 to 5.9
	€/$ exchange rate	1.3 to 1.3	1.3 to 1.4
	Public finance rule	Stabilisation of public debt	Stabilisation of public debt

*: Nominal Government bond yields, 10 years' maturity.

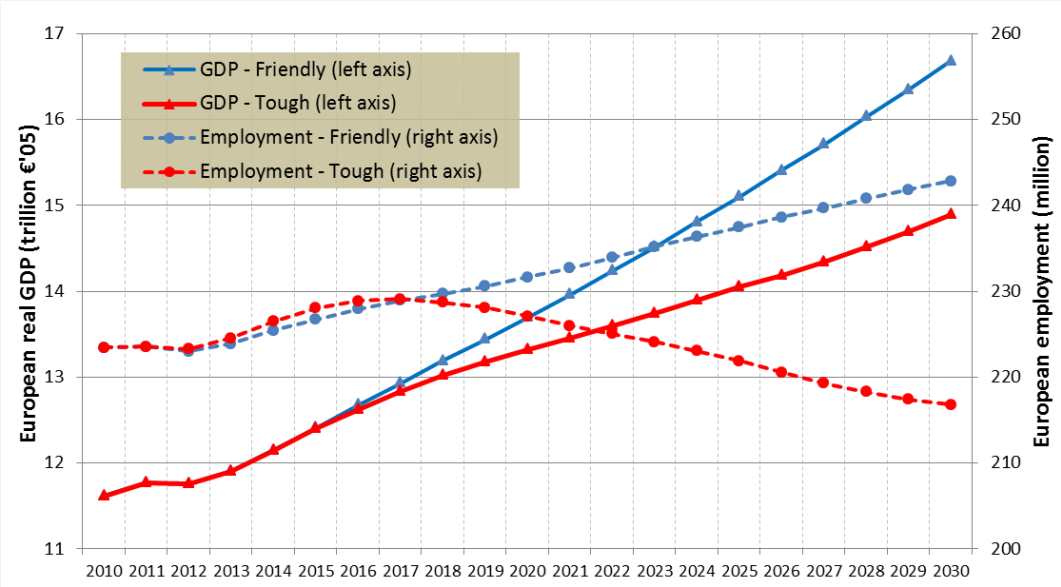
[12]To illustrate this risk, the CAS (2012 [42]) did a shock, with the NEMESIS model, of a one point increase of the real long-term interest rate (from 2% to 3%) in France and found a 3.3% loss of GDP and 1.5% loss of employment at long-term (15 years).

[13]There is a different interest rate for each European country in order to take into account the different sovereign debt risks.

3 Two pathways for future European economy

These two global contexts, the "Friendly" and the "Tough", characterised by different drivers evolution, are expected to generate different pathways for the European economy between 2015 and 2030[14] (see figure 3.1). Even if the overall drivers presented in section 2 have an impact on the European economy, the most important ones are the change in the **European population** projections, the **public finance** and, at a lesser extent, the **energy prices**. The following will present hypothesis on population and public finance and their consequences for European economy.

Figure 3.1: European real GDP and employment



Source: NEMESIS model.

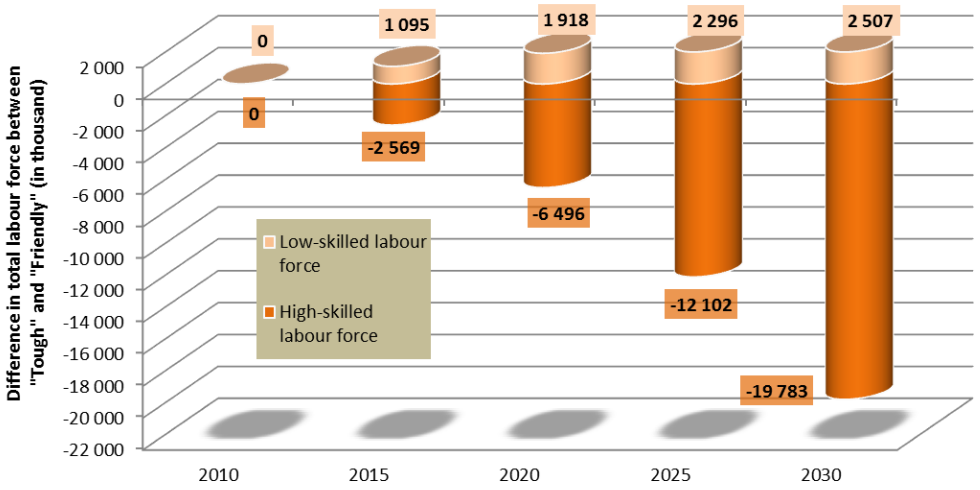
3.1 European economic growth driven by high-skilled supply

As presented in section 2, the change in European population structure is expected to be very important in 2030. Even if ageing of European population occurs in both scenarios, it is more marked in the "Tough" scenario than in the "Friendly" one. The European **labour force** in the "Friendly" scenario is expected to grow by 15.6 million in 2030 compared to 2010 whereas it falls about -1.7 million in the "Tough" scenario. Thus, there is around 17 million less of active population in the "Tough" than in the "Friendly" scenario (see figure 3.2). This difference between the scenarios is also explained by the weak increase of the European high-skilled labour supply in the "Tough" context. Figure 3.1 shows this difference. In 2030, in the "Friendly" scenario, the high-skilled active population is expected to rise by more than 35 million compared to 2010. In the "Tough" case, this growth is limited to 15.5 million *i.e.* less than half of the "Friendly" scenario. Thus, the European high-skilled labour supply is

[14] Detailed economic results for each members stateare available in the statistical annex.

20 million higher in the "Friendly" scenario in 2030. European low-skilled labour supply is expected to be 2.5 million lower in the "Friendly" scenario in 2030.

Figure 3.2: Difference in European high and low-skilled supply force between "Tough" and "Friendly"



Reading: in 2020, it is expected +6.496 million high-skilled labour supply on the European labour market in the "Friendly" compared to the "Tough" scenario.

Source: NEMESIS model based on Huisman *et al.* (2012 [37]).

3.2 Sovereign debt burden as the Damocles' sword

The second main driver of the European economy pathway up to 2030 is the **public finance** (see Box 3.2 for details on public finance rules applied in each scenario). The 2009 subprime mortgage crisis has led to a fall of general government revenues and a rise of their expenditures in order to avoid a more profound recession. The countercyclical evolution of public finance has resulted in an important rise of general government public debt particularly in all European countries where it was already important. The level of sovereign debt in the European Union has reached an unprecedented level (around 85% of GDP in 2012), leading to the current European sovereign debt crisis. Regarding this imbalance of European public finance, special attention was paid to the public debt stabilisation in both scenarios. In the "Friendly" case, a progressive stabilisation of the general government debt in GDP percentage has been reached and, once this stabilisation was completed, a slightly reduction has been imposed. In the "Tough" scenario, for which economic growth was expected to be lower than in the "Friendly" scenario, it was imposed to reach the same level of sovereign debt of the "Friendly" scenario by reducing government expenditures (see Box 3.2 for details and table 3.1 for general government debt evolution in EU member states). Thus, the general government debt returns to a more sustainable level in the European Union at the end of the period (around 70%). Since public demand is relatively important in the structure of European economies, these budgetary efforts have a downside impact on European economic growth during the period (different impacts according to the scenario). Nevertheless, this budgerary efforts will enhance long-term economic growth by relaxing sovereign debt burden.

Box 3.2: Stabilisation rules for public finance

In order to stabilise the general government debt that have reached a unprecedented level during the European sovereign debt crisis, some rules have been implemented within each scenario.

- "Friendly" scenario

From 2012, public expenditures are maintained at a moderated level up to the stabilisation of the ratio between general government debt and GDP. Once the level of general government primary balance that enables the stabilisation of public debt has been reached, this level is maintained to initiate the reduction of the general government debt (in GDP points).

- "Tough" scenario

In the "Tough" scenario, the previous rules implemented in the "Friendly" scenario remain. Nevertheless, after 2015, if the sovereign debt, in terms of GDP points, is higher than in the "Friendly" scenario, the general government expenditures are reduced allowing to progressively reach a similar (+/- 5 points) level of general government debt in terms of GDP percentage than in the "Friendly" scenario.

Table 3.1: General government debt in GDP point

"Friendly"

	2010	2015	2020	2025	2030
AT	72%	72%	62%	54%	49%
BE	96%	104%	101%	97%	91%
CZ	38%	42%	37%	33%	29%
DE	83%	73%	62%	59%	58%
DK	43%	46%	42%	40%	37%
EE	7%	5%	11%	15%	18%
ES	61%	83%	77%	71%	67%
FI	48%	48%	43%	38%	34%
FR	82%	92%	87%	85%	83%
GR	145%	175%	168%	168%	158%
HU	81%	104%	107%	106%	103%
IE	93%	131%	128%	118%	114%
IT	119%	121%	113%	110%	108%
LT	38%	47%	48%	51%	55%
LU	19%	23%	24%	24%	24%
LV	45%	45%	36%	30%	23%
MT	69%	69%	59%	46%	36%
NL	63%	76%	73%	63%	54%
PL	55%	61%	59%	57%	54%
PT	93%	115%	107%	105%	101%
RO	30%	44%	42%	42%	41%
SE	39%	37%	30%	25%	22%
SI	39%	60%	59%	58%	57%
SK	41%	51%	49%	33%	19%
UK	80%	102%	101%	100%	94%
CY	62%	88%	80%	73%	66%
BG	16%	19%	14%	9%	4%
EU	80%	87%	80%	76%	72%

"Tough"

	2010	2015	2020	2025	2030
AT	72%	73%	67%	58%	45%
BE	96%	104%	107%	107%	96%
CZ	38%	43%	41%	35%	25%
DE	83%	74%	68%	66%	60%
DK	43%	46%	44%	38%	32%
EE	7%	8%	16%	14%	9%
ES	61%	84%	82%	76%	66%
FI	48%	49%	44%	36%	29%
FR	82%	92%	90%	86%	79%
GR	145%	174%	169%	175%	163%
HU	81%	104%	113%	115%	104%
IE	93%	131%	136%	130%	114%
IT	119%	121%	117%	114%	109%
LT	38%	48%	51%	52%	51%
LU	19%	24%	29%	28%	20%
LV	45%	47%	40%	27%	15%
MT	69%	70%	66%	53%	34%
NL	63%	76%	77%	68%	52%
PL	55%	61%	62%	58%	50%
PT	93%	115%	111%	109%	100%
RO	30%	47%	51%	47%	36%
SE	39%	38%	30%	22%	17%
SI	39%	61%	64%	60%	51%
SK	41%	51%	52%	36%	14%
UK	80%	101%	104%	102%	93%
CY	62%	87%	82%	77%	66%
BG	16%	24%	25%	17%	0%
EU	80%	87%	84%	80%	71%

Source: NEMESIS model

3.3 Financial constraint penalises the effective economic growth

The strong influence of the labour force and the financial constraints on potential growth (in addition to other factors like energy prices or interest rates for instance), lead to contrasted GDP growth rates between the countries and the scenarios until 2030. Table 3.2 displays the annual average real GDP growth rate by 5-years step for each EU27 country and for each scenario.

Table 3.2: 5-years steps average GDP growth rates

"Friendly"

	2010-2015	2015-2020	2020-2025	2025-2030
EU	1.33	1.99	1.98	2.01
AT	1.73	1.99	1.86	1.79
BE	1.31	1.94	2.00	2.17
BG	1.96	3.40	2.86	2.61
CY	0.68	3.92	3.75	3.69
CZ	1.92	2.61	2.59	2.64
DE	2.02	1.53	1.39	1.35
DK	1.53	1.86	1.85	1.92
EE	4.73	4.21	4.00	3.95
ES	0.11	2.56	2.83	2.53
FI	1.91	2.23	2.16	2.20
FR	1.59	2.09	2.15	2.17
GR	-2.29	2.06	2.57	2.45
HU	0.50	1.14	1.59	2.08
IE	1.60	1.82	2.11	2.53
IT	0.67	1.87	1.71	1.72
LT	4.48	4.18	3.49	3.30
LU	1.67	3.07	3.23	2.88
LV	3.90	4.12	3.26	3.37
MT	1.98	2.58	3.03	2.97
NL	0.83	1.84	1.80	1.84
PL	2.94	2.83	2.66	2.50
PT	-0.69	2.16	2.00	2.01
RO	2.72	4.22	4.21	4.24
SE	2.22	2.87	2.56	2.30
SI	0.56	2.72	2.61	2.74
SK	3.21	3.04	2.83	2.89
UK	1.20	1.72	1.76	2.04

"Tough"

	2010-2015	2015-2020	2020-2025	2025-2030
EU	1.31	1.44	1.08	1.18
AT	1.67	1.28	1.03	1.19
BE	1.30	1.39	1.10	1.20
BG	1.73	1.67	1.93	2.28
CY	0.64	3.20	1.67	1.56
CZ	1.87	1.91	1.68	2.00
DE	1.95	1.03	0.64	0.61
DK	1.53	1.14	1.20	1.76
EE	4.60	3.12	3.04	3.95
ES	0.08	1.62	1.28	0.91
FI	1.93	1.49	1.50	2.06
FR	1.62	1.87	1.34	1.64
GR	-2.21	1.90	1.01	0.85
HU	0.43	0.49	0.77	1.23
IE	1.49	1.17	1.15	1.52
IT	0.62	1.16	0.70	0.57
LT	4.49	3.66	2.97	3.14
LU	1.49	2.18	2.45	2.15
LV	3.70	2.75	2.46	3.31
MT	1.80	1.20	1.74	2.21
NL	0.67	1.17	0.75	0.80
PL	2.94	1.92	1.43	1.89
PT	-0.64	1.67	0.82	0.61
RO	2.41	2.64	2.95	3.62
SE	2.21	1.70	2.34	2.08
SI	0.54	2.08	1.76	2.22
SK	3.24	2.54	1.91	2.29
UK	1.23	1.48	1.04	1.26

Source: NEMESIS model

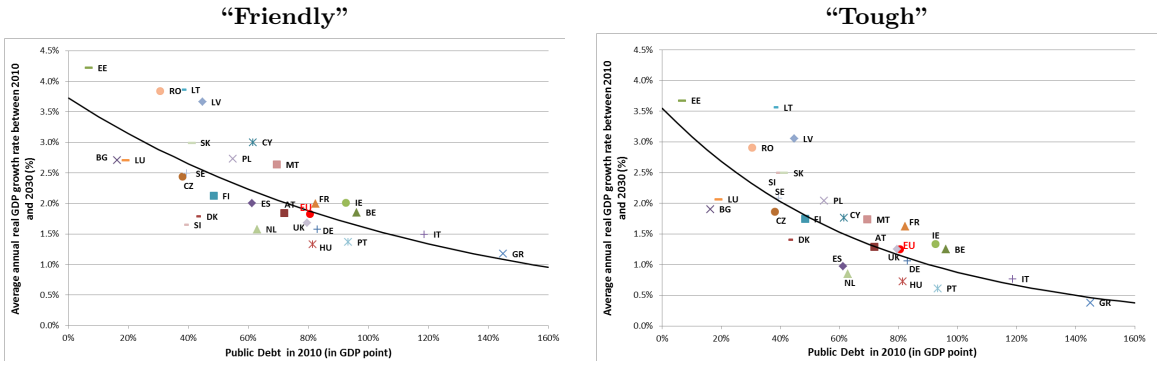
The **"Friendly" scenario** is characterised by a "GDP growth released". Indeed, economic growth gets closer to its potential after the 2010-2015 recovery, during which the real GDP growth rates remain weak[15]. At the European level, economic growth is expected to be around 2% between 2015 and 2030. The real GDP growth rates are relatively high in Central and Eastern Countries (CEEC) with more than 4% in Romania and around 3% in Slovakia while economic growth within the western European countries is weaker and more contrasted. Spain and Sweden are expected to grow at 2.5% whereas the real GDP growth rate in Germany or the Netherlands is about 1.4% and 1.8% respectively. These differences could be partially explained by comparing the evolution of the labour force. For instance,

[15] See *e.g.* OECD (2012 [50]) for an assessment of GDP long-term potential growth.

labour force is expected to decrease by 1.5 million (*i.e.* -3%) between 2010 and 2030 in Germany in the "Friendly" scenario whereas the Spanish labour force is supposed to increase by about 3.2 million (*i.e.* +13.5%). Furthermore, the importance of public debt burden at the beginning of the period lowers public expenditures and the average economic growth rates all along the period (see figure 3.3). This burden could explain a part of the economic growth differential on the period, whose effect is reinforced in the "Tough" scenario.

In the **"Tough" scenario**, economic growth is significantly lower than in the "Friendly" scenario and so this scenario can be characterised as a "continued economic crisis". The weaker increase of European labour force and at a lesser extent higher energy prices, interest rates and exchange rates tend to reduce the European economic growth. This weaker GDP growth impacts directly public finances and obliges the European governments to reduce their expenditures in order to maintain a sustainable level of sovereign debt. A "snowball effect" appears, since the decrease of general government expenditures accentuates the weakening of economic growth already impacted by the declining labour force and the high energy prices. Therefore, in addition to a deteriorated situation on labour market, the tight budgetary policy leads to a loss of 0.75 point of economic growth per year in average between 2015 and 2030 in the European Union. Thus, contrary to the "Friendly case", the European economy does not succeed in overcoming the debt crisis. GDP growth rate is then strongly affected until 2030. For instance, Spain and Greece lose respectively 1.4 point and 1 point of real GDP growth rate per year compared to the "Friendly" scenario whereas the real GDP growth rate of Sweden reduces by 0.5 point per year between 2015 and 2030.

Figure 3.3: Relationship between long-term GDP growth rates and public debt in 2010



Source: NEMESIS model

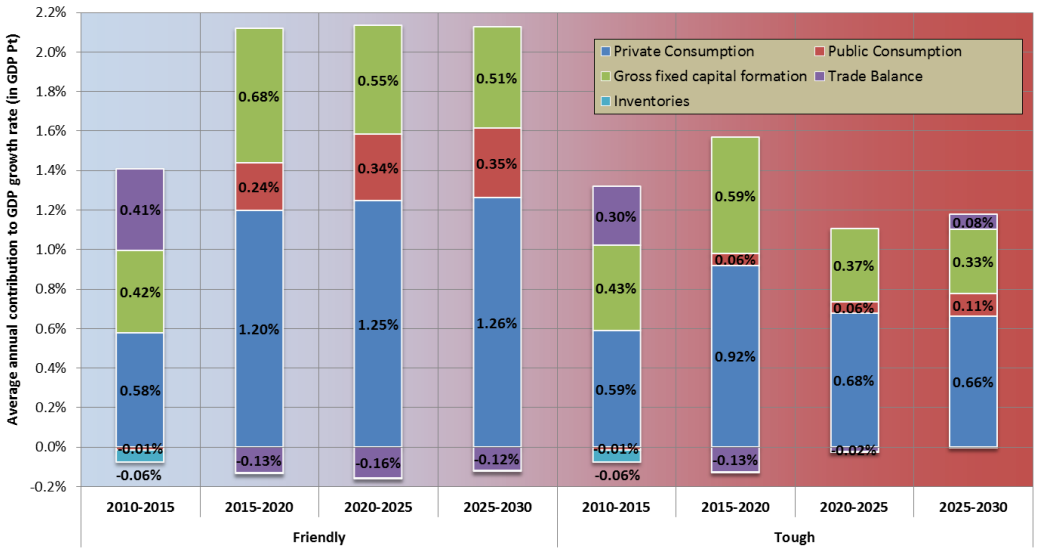
Figure 3.3 displays the **relation between long-term economic growth and public finance imbalance** in 2010 and shows a **clear correlation** between these variables in both scenarios. Indeed, countries with a high general government debt (in GDP points) in 2010 have generally a lower long term economic growth insomuch as their government must generate primary surplus to allow themselves flexibility. Besides, the correlation between average GDP growth rate and public financial situation in 2010 is stronger in the "Tough" scenario. Indeed, despite some favourable conditions for the long-term potential economic growth, the imbalance of public finances counterbalances those positive drivers. It

is the case in Spain where despite the growth of high-skilled labour force in the "Tough" (+2.7 million *i.e.* +42%), the rigour policy tends to reduce the GDP growth rate of about 1.4 point per year between 2015 and 2030 compared to "Friendly" case, as pointed out above[16].

3.4 The engine of growth

During the recovery period (2010-2015), the structure and the level of economic growth is almost the same in both scenarios insomuch as the strong constraint of financial adjustment on internal demand prevents other drivers, like demography , from having any visible influence on growth. Therefore, the reference scenarios do not seem differentiated during this period.

Figure 3.4: 5-years steps average annual contribution to real GDP growth rate (in GDP point)



Source: NEMESIS model

Indeed, **the contributions to GDP growth** of investments and private consumption are weak and even negative for public consumption and for inventories in both cases (see figure 3.4). The average annual growth rate of GDP between 2010 and 2015 is very weak, 1.4% in the "Friendly" scenario and 1.3% in the "Tough" one. The consequence is a reduction of imports (weakness of internal demand) in addition to a positive dynamic of exports (the rationalisation of production costs) and an enhancement of the trade balance. During the recovery period, the external trade balance contributes to 0.4 point to GDP growth in the "Friendly" scenario and to 0.3 point in the "Tough". Thereafter, the scenarios are more differentiated.

[16] All the drivers for the "Tough" scenario have been implemented together, so none analysis can provide the "direct" effect of each of them. Nevertheless, regarding previous works achieved with the NEMESIS model, such as in Jolly *et al.* (2012 [42]), it is possible to provide a rough estimation of the impact of each driver on European GDP growth. Of about the 0.75 point of GDP growth loss in the "Tough" scenario, 0.1 pt could be attributed to energy prices, 0.25 pt to interest rates, 0.35 pt to labour supply and the rest to others drivers (World demand, exchange rates, etc). These estimations also include the feedbacks effects on public finance.

After the recovery period, in the "Friendly" scenario, more usual drivers of GDP growth rates contribute to the European economic growth. Between 2015 and 2020, the contribution to GDP growth of the European public consumption turns positive but remains moderated with +0.24 point, and gross fixed capital formation contributes importantly to the European economic growth with almost +0.7 point. The long term economic perspectives are more favourable, so higher investments returns are foreseen, boosting the gross fixed capital formation. After 2020, domestic demand is the main driver of the European GDP growth rate (+1.25 point of GDP for private consumption and +0.35 for public consumption). In the "Tough" scenario, after 2015, the contribution to growth of public consumption is less than 0.1 point due to governments' expenditure cuts . Furthermore, the contribution of the private consumption is low (between 0.9 point and 0.6 point) due to the negative multiplier effects of public expenditure. The degradation of economic perspectives impacts capital formation (less than +0.4 point of GDP growth after 2020). Furthermore, in the "Friendly" scenario, external balance never contributes positively to GDP growth rate after the recovery period. On the contrary, due to low internal market demand in the "Tough" scenario, external trade contributes positively to GDP growth. To sum up, in the "Friendly" scenario, recovery allows a progressive return to potential economic growth but in the "Tough" scenario, debt burden constrains effective economic growth during the whole period 2010-2030.

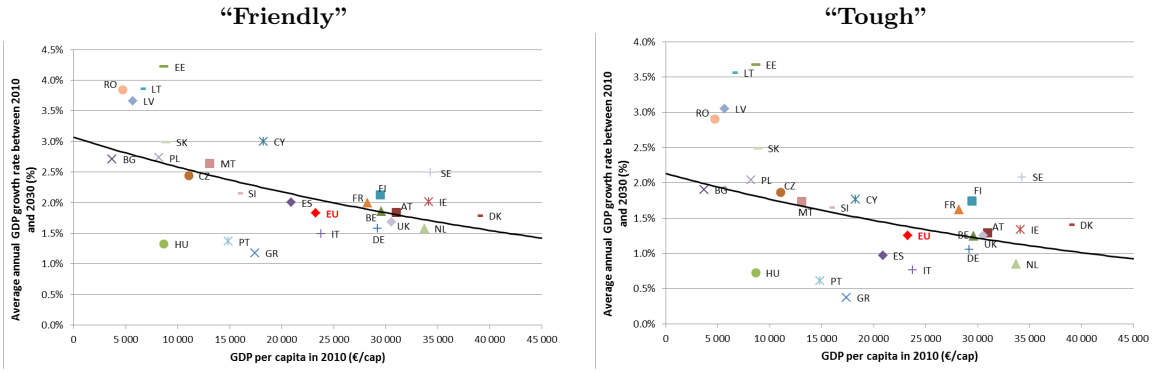
3.5 Is there convergence within EU27?

Global wealth of European population is increasing in both scenarios between 2010 and 2030 insomuch as European real GDP per capita rises by 26% in the "Tough" case and 39% in the "Friendly" case. The analysis of GDP per capita and GDP lead to different conclusions. Indeed, as an example, the German GDP per capita grows faster than the Spanish one in both scenarios (respectively +45% and +39% in the "Friendly case" for instance) although the average annual growth rate of GDP is higher in Spain (almost 0.5 point of GDP more in the same case). Furthermore, between 2005 and 2030, the growth of GDP per capita in the CEEC is higher than in the EU15, with +113% instead of +37% in the "Friendly" case. Knowing that the CEEC start with an average GDP per capita around four times smaller, it could be a first insight of the economic convergence among the European countries.

There are several ways to explore the hypothesis of economic convergence between countries. The economic literature mainly distinguishes two types of convergence (Barro and Sala-i-Martin, 2003 [4]) *(i)* the β-convergence which implies that the poorest economies grow faster than rich ones, and *(ii)* the σ-convergence which is the reduction of the dispersion of levels of income per capita across economies. The classical way to test the β-convergence is to use econometrics which is not relevant in our case of projected data. Nevertheless the figure 3.5 provides some insights on this β-convergence within EU27 in both scenarios. Indeed, it seems that the lower the initial income per capita, the higher is the economic growth rate (the relation appears more accurate in the "Friendly" case)[17].

[17] This result is more robust when Hungary, Greece and Portugal are excluded from the sample. The influence of their initial income per capital is offset by their public finance imbalances which are the predominant determinant for GDP growth rates (see the previous section).

Figure 3.5: GDP convergence between EU countries



Source: NEMESIS model
NB: Luxembourg have been excluded from the analysis.

Moreover, the σ-convergence (calculated here as the standard error of European incomes per capita divided by the mean of the sample), and then the dispersion of the income per capita, is declining in both scenarios between 2010 and 2030 (see table 3.3). This last result would allow the possibility of a β-convergence since a β-convergence is necessary (but not sufficient) for the σ-convergence (Barro and Sala-i-Martin, 2003). The dynamics of convergence among the European member states has been shown for the last three decades (*e.g.* Monfort, 2008 [48]), although the ongoing convergence is mainly due to the catching up of the CEEC countries with the richest ones. Indeed, the convergence is no longer occurring among EU-15 members (confirmed by figure 3.5).

Table 3.3: σ convergence analysis in both scenarios

	2010			2030		
GDP per capita	Standard error	Mean	σ convergence	Standard error	Mean	σ convergence
Friendly	14 851	21 508	0.6905	18 753	30 602	0.6128
Tough				16 952	27 771	0.6104

Unit: GDP per capita in €'05 per inhabitant
Source: NEMESIS model

Finally, the table 3.3 shows that there is no influence of the scenario on the σ-convergence. Two phenomenons are playing: *(i)* the "Tough" scenario would have reduced the gap between western countries and CEEC, because these last countries are the less endebted and then less sensitive to higher interest rate, *(ii)* but on the other hand the gap is increasing among western countries.

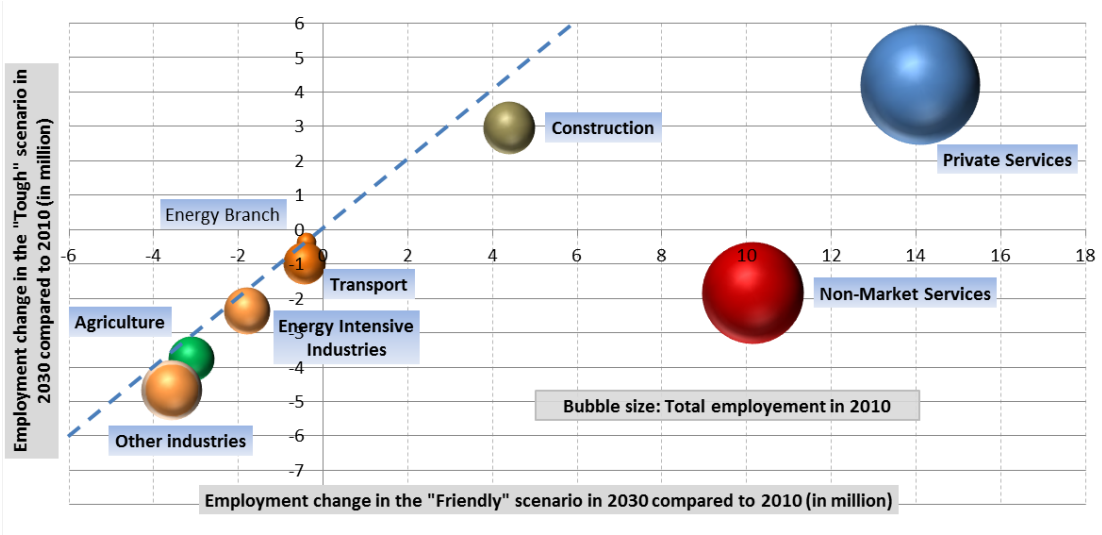
4 Towards high-skilled services

4.1 Global features on European employment

In the "Friendly" scenario, there are 19.3 million jobs created between 2010 and 2030 whereas **there are 6.7 million jobs destroyed in the "Tough" scenario** during the same period (see figure 3.1). The different pathways of European employment in both scenarios mainly come from the difference in European economic development between 2020 and 2030. Indeed, more than 8 million jobs are created in 2020 compared to 2010, in the "Friendly" scenario while the employment growth is half, in the "Tough" scenario, with +3.6 million jobs. After 2020, figures are more contrasted, in the "Friendly" scenario, job creation is slightly more important than in the previous decade with +11 million new jobs (*i.e.* around 3 million more jobs). In the "Tough" scenario, the picture is totally reversed, around 10.3 million jobs are destroyed in 2030 compared to 2020. Indeed, the weak European economic growth (around 1.1%), during this period, does not allow for the creation of new jobs up to 2030. On the contrary, it destroys 4.5% of the total European employment compared to 2020 and unemployment rate remains very high with almost 12% in 2030. Then, the weakness of European economy leads to a tough European labour market in which the fall of labour demand is faster than the fall of labour supply.

4.2 Redeploying towards services

Figure 4.1: European sectorial employment change between scenarios



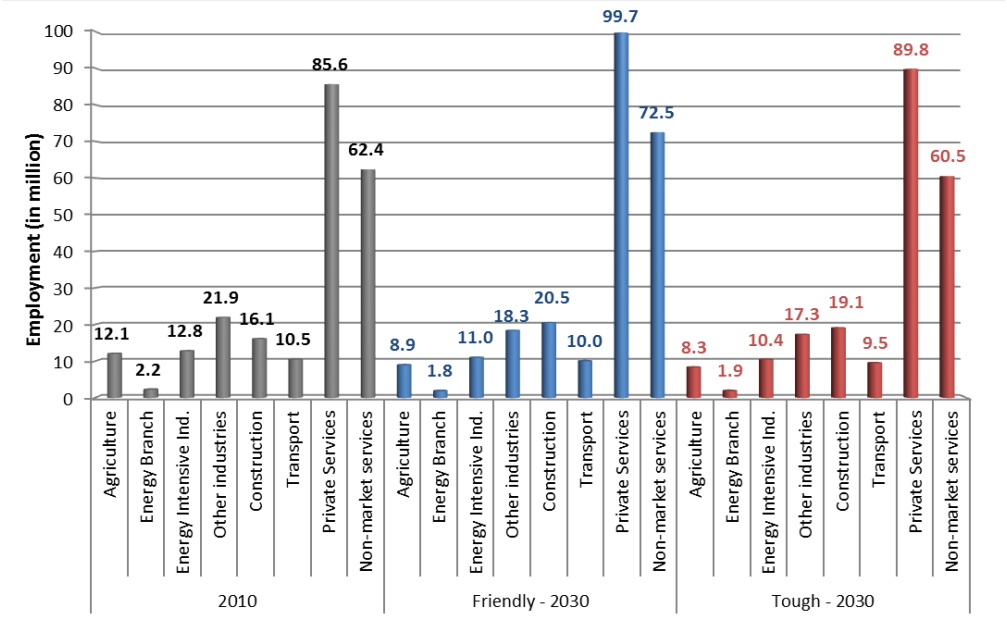
Reading: in the construction sector, there is 4.4 million and 3 million more jobs respectively in the "Friendly" scenario and in the "Tough" one in 2030 compared to 2010 (the initial level in 2010 was 16 million).
Source: NEMESIS model.

Looking at the European sectorial employment figures in both scenarios allows a better understanding of the sectorial mechanisms playing in these macroeconomic results. Figure 4.1 confronts the change of

sectorial European employment between "Friendly" and "Tough" scenarios. Obviously, workers in non-market services are the most impacted by the slack of public expenditures between the "Tough" and the "Friendly" scenarios, total employment in non-market services is then reduced by about 12 million (*i.e.* 19% of the level in 2010) in 2030 when passing from "Friendly" to "Tough". Public expenditures for social protection, education, economic affairs, education as well as defence or general public services are lowered significantly in the "Tough" scenario. In 2030, total public consumption passes from €3.2 trillion (€ constant 2005) in the "Friendly" scenario to €2.6 trillion in the "Tough" scenario.

In the "Friendly" scenario, employment growth is mainly driven by **job creation in the private services sectors** with +9.2 million between 2010 and 2020 and +4.9 million between 2020 and 2030 *i.e.* +14.1 million between 2010 and 2030 (see figure 4.2). The construction sector also exhibits non negligible job creation with +4.4 million employments in 2030 compared to 2010 while in the European industries, employment decreases by -5.8 million jobs and especially -2.6 million in the first decade. Finally, agriculture loses about 3.1 million jobs between 2010 and 2030 (*i.e.* -26%), the largest decrease in percentage with energy intensive industry and other industries.

Figure 4.2: European sectorial employment



Source: NEMESIS model

In the "Tough" scenario, as explained previously, the fall in employment growth is very large in the non-market services with -1.8 million jobs in 2030 compared to 2010. But it is also very important in the private services for which employment is 10 million lower than in the "Friendly" scenario, even if it is still rising by 4.2 million. For industry and construction, the differences between both scenarios are less accentuated, industries destroy 7.4 million jobs and construction creates only 3 million jobs. Finally agriculture is the less impacted sector by the economic growth slowing down, it losses 3.7 million jobs *i.e.* only -600 000 compared to the "Friendly" scenario.

4.3 European sectorial employment in a historical perceptive

Looking at **the European sectorial employment historical trends** in table 4.1 for the decade 1995-2005, past trends are reproduced in the "Friendly" scenario (except for non-market services) but at a lesser extent. In the "Friendly", the European Union is still destroying employment in the industry -2.6 million between 2010 and 2030 and -3.1 between 2020 and 2030 compared to -4.1 million between 1995 and 2005. This lesser employment loss in industries displays the slow down of offshoring of the manufactured activities. Indeed, the economic incentives of offshoring manufacturing activities outside EU are reduced because:

- the non-relocated goods now represent an important weight in the overall industrial goods resulting from strong offshoring in past decades and
- emerging countries raise their standard of living when developing, which leads to a rise in their production cost.

Table 4.1: Sectorial European employment change by 10 years-step

		Friendly		Tough	
	1995-2005	2010-2020	2020-2030	2010-2020	2020-2030
Agriculture	-3 979	-1 468	-1 641	-1 552	-2 197
	-22.3%	*-12.2%*	*-15.5%*	*-12.9%*	*-20.9%*
Industry	-4 084	-2 642	-3 120	-2 676	-4 681
	-9.4%	*-7.2%*	*-9.1%*	*-7.2%*	*-13.7%*
Construction	+1 533	+3 040	+1 350	+3 034	-54
	+10.8%	*+18.9%*	*+7.1%*	*+18.9%*	*-0.3%*
Private services	+16 697	+9 344	+4 331	+7 978	-4 717
	+22.7%	*+9.7%*	*+4.1%*	*+8.3%*	*-4.5%*
Non-market services	+8 285	-69	+10 224	-3 165	+1 334
	+16.0%	*-0.1%*	*+16.4%*	*-5.1%*	*+2.3%*

NB: Evolution in thousand expect italicized figures (in %).
Source: Historical data (WIOD, 2012 [56]), NEMESIS model

Agriculture still presents high labour productivity in EU. Nevertheless, in twenty years (2010-2030), the agricultural employment loss is similar to 1995-2005 losses. The agricultural employment falls by 1.5 and 1.6 million between 2010-2020 and 2020-2030 respectively whereas it has fallen about 4 million between 1995 and 2005. In private services, employment growth is still important with +9.3 and +4.3 million between 2010-2020 and 2020-2030 respectively but less than during the 1995-2005 decade (+16.7 million between 1995 and 2005). This slowing down of employment growth in private services could be explained by several factors:

- a slow down of the outsourcing of tertiary task in the industry (*e.g.* logistics or marketing),
- a higher exposition of services offshoring due to a rise of skills in emerging countries,
- more and more services are easily relocated thanks to information and communication technologies (ICT) development (*e.g.* online services, call centre, etc.) and

- a rise of private services productivity through *e.g.* an enhancement of ICT uses and integration within private services.

And finally, in addition to non-market services, the growth engine sectors (*i.e.* private services in the "Friendly" scenario) do not develop, in the "Tough" scenario. The creative destruction (or Schumpeter' gale - Schumpeter 1942 [51], employment destruction in industry and employment creation in services) existing in the "Friendly" scenario does not happen in the "Tough" one. Worse, after 2020, only the destruction process takes place in the private services sectors. Private services lose almost 5 million jobs between 2020 and 2030 in the "Tough" scenario (*i.e.* -9 million jobs compared to Friendly). Others sectors also face difficulties but at a lesser extent than services. Thus, **the "Tough" scenario can be viewed as a wasted opportunity** for high job-creating sectors.

4.4 Do skills matter?

Another interesting point to analyse the employment evolution in both scenarios is the change in the level of skill of employment. There are two levels of skill in the NEMESIS model *(i)* high-skilled, corresponding to ISCED[18] 5 & 6 and *(ii)* low-skilled corresponding to ISCED 0 to 4. The following analysis proposes to explore the skill influence regarding employment changes in both scenarios following different sectorial typology[19]:

- sectors strongly exposed to international competition and sectors less exposed (see figure 4.3)
- and a classification by the degree of innovation, technology or skills requirement in the production process (see figure 4.4).

Figure 4.3 displays the change in labour demand by level of skill in the **exposed and less-exposed sectors** between 2010 and 2030 in both scenarios. Starting from total employment, the exposed sectors to international competition are expected to destroy employment by -5.4 million jobs in the "Friendly" and -6 million in the "Tough". Considering this weak difference and the larger one in less-exposed sectors, it confirms that the difference in economic development between scenarios comes from the European internal market demand. Indeed, there are moderated employment gains in the "less-exposed" sectors in the "Tough" scenario, only 8.7 million new jobs are created, while there are more than 23 million in the "Friendly" scenario.

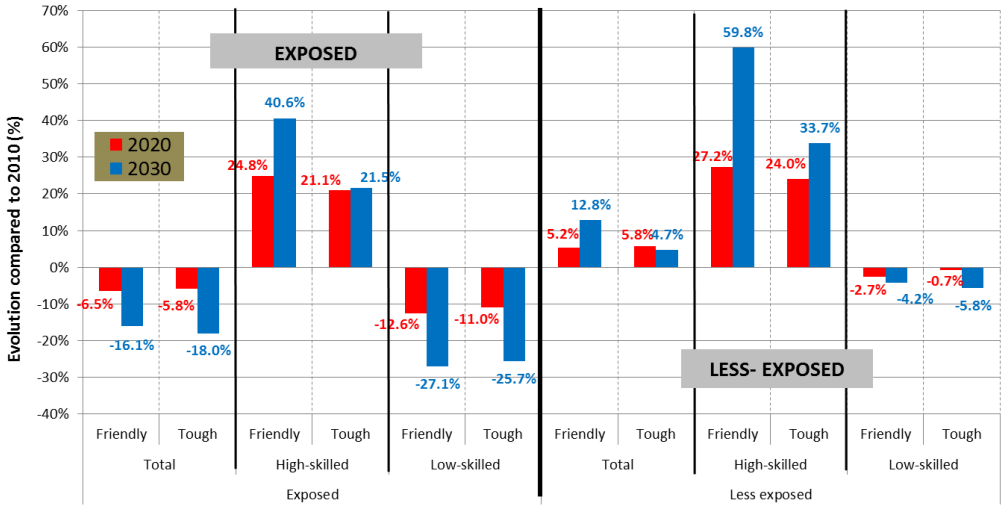
Focusing on skills requirement in both scenarios, labour demand for high-skilled jobs increases about 31.6 million and 17.8 million in the "Friendly" and "Tough" scenarios respectively. On the contrary, 13.3 and 15.1 million low-skilled employments are destroyed between 2010 and 2030 in the "Friendly" and "Tough" scenarios respectively. Thus, high-skilled employment is increasing in both scenarios, but it rises two times more in the "Friendly" scenario than in the "Tough" one. However, the low-skilled jobs destruction is at a similar extent in both scenarios. Those changes emphasise the **unappeasable process of low-skilled job destruction** in the EU in the long term. In other words, **new jobs in the EU will be high-skilled jobs**.

[18] International Standard Classification of Education.

[19] NEMESIS sectors mapping with both typologies could be found in appendix. The classification by the degree of innovation, technology or skills requirement is based on the work acheived by Jolly *et al.* (2012 [42]).

Figure 4.3 shows that high-skilled employment grows as well as in exposed sector (up to +46% in "Friendly" in 2030 compared to 2010) than in less-exposed sectors (up to +60% in the same case). In order to remain competitive, exposed sectors should enhance process and goods by increasing their quality or enlarging variety. To do this, exposed sectors need more skilled workers able to manufacture more complex products. For instance, the share of high-skilled employment in the equipment transport sector rises from 21% in 2010 to 36% in 2030, in the "Friendly" scenario.

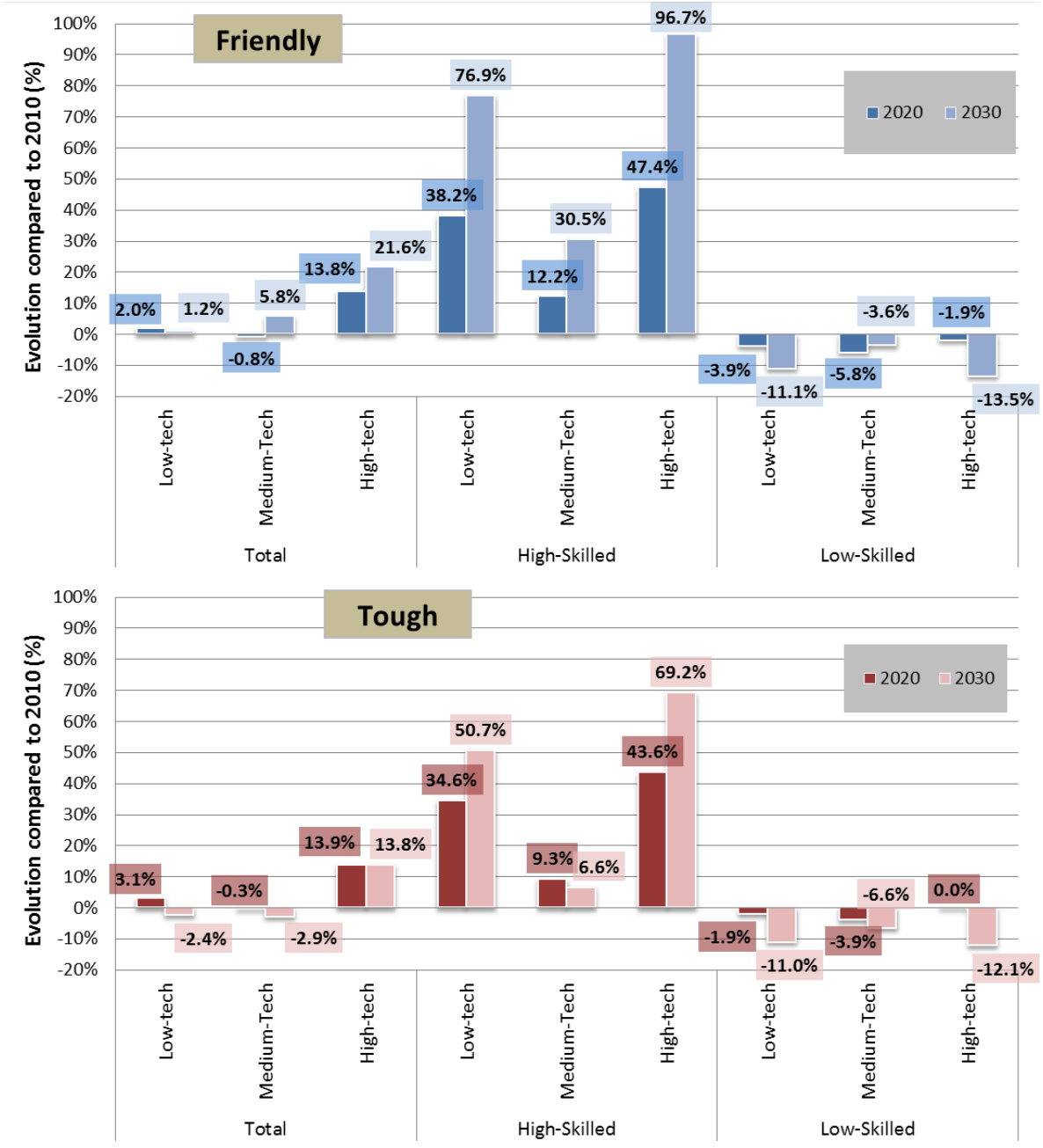
Figure 4.3: European employment in exposed and non-exposed sectors



Source: NEMESIS model

In the less-exposed sectors which are also the most new job creating sectors, the supply of new high value added services or products calls for high and diverse skills. In agriculture sectors, classified as less-exposed to international competition, productivity gains remain important. Thereby, agricultural holdings are expected to be largest and the skills requirement (*e.g.* agronomics, environmental sciences or management) is increasing. In the "Friendly" scenarios, the share of high-skilled employment passes from 7.5% in 2010 to 12% in 2030 while agriculture sector loses more than 3 million jobs in two decades. This 'skillisation' of agriculture sector is less important in the "Tough" scenario, the share reaching 10% in 2030, but it remains significant. In the services sectors, which are less-exposed to international competition, the share of high-skilled workers is also strongly increasing even in sectors for which the current share is important. For instance, in the communication sectors, in which labour productivity is historically very high, the share of high-skilled jobs in EU reaches 35% and 30% in 2030 in the "Friendly" and "Tough" scenarios respectively compared to 20% in 2010. Thereby, there is **a process of 'skillisation' in overall European sectors**.

Figure 4.4: Sectorial European employment according to technological advancement



Source: NEMESIS model

For low-skilled workers, the figures are very clear. Both exposed and less-exposed sectors destroy low-skilled jobs. Nevertheless, this low-skilled employment destruction is more important in the exposed than in the less-exposed sectors. Besides, sectors like construction or lodging and catering, characterised by the largest share of low-skilled employment and by weak exposure to international

markets, are also the only sectors in which the low-skilled employment increases between 2010 and 2030 in both scenarios. In these sectors, the share of high-skilled workers is increasing but, contrary to other sectors, the low-skilled employment is also progressing. Insomuch as most of the low-skilled workers of these sectors do manual non-routine tasks, these evolutions could be explained by a skill polarisation of the labour market[20] (CEDEFOP, 2011 [10]).

It is also interesting to look at the employment change regarding **sectorial degree of technological complexity**[21] to confirm the previous analysis. Figure 4.4 displays the employment change by skills between 2010 and 2030 in both scenarios regarding the technological advancement of the sectors. Three class groups of technological advancement have been established: sectors characterised by *(i)* a weak technological requirement for production process (called *low-tech*), *(ii)* a moderated one (called *medium-tech*) and *(iii)* an important one (called *high-tech*). It is visible that the largest high-skilled employment growth arises in high-tech sectors with almost a doubling in "Friendly" scenario between 2010 and 2030. However, non-negligible increase of high-skilled employment occurs in the low-tech sectors with more than +75% in the "Friendly" scenario in 2030 compared to 2010. Finally, the high-skilled workers also rise in medium-tech services but at a lesser extent than in both others sectors. These pictures supplement the previous ones and confirm the 'skillisation' of European labour market in all sectors. On the one hand, the skills requirement in all sectors, even in the less technological, is increasing and on the other hand, the new entrants on labour market are mainly skilled workers. Figure 4.4 also confirms the growth dynamic of some sectors namely high-tech ones whereas the "Tough" scenario sounds as a scenario of missed opportunities. Both scenarios create high-skilled jobs and destroy low-skilled ones. Nevertheless, the loss of low-skilled workers in the high-tech sectors is smaller in the "Tough" scenario (with -4.3 million in 2030 compared to 2010 *i.e.* -12%) than in the "Friendly" (with -4.8 million *i.e.* -13.5%). Medium and low-tech sectors exhibit similar figures with weak differences in low-skilled employment between scenarios. These observations confirm that **European economic growth in both scenarios comes from more high-skilled jobs** in dynamic sectors such as services.

4.5 Nevertheless the high-skilled unemployment remains

A curiosity in the employment results, in spite of the important creation of new high-skilled jobs, is the unemployment rate in 2030 which increases from 5.6% in 2010 (7.5% in 2012) to 7.7% in the "Friendly" scenario and 10.5% in the "Tough" (see table 4.2). Is this curiosity a result of the modelling approach or does it reveal a more fundamental economic difficulty?

[20] The concept of labour market polarisation described by Autor *et al.* (2006 [3]) or more recently CEDEFOP (2011 [10]) or Maselli (2012 [45]), can be theoretically interpreted by the "skill biased technological change" idea. Indeed, technical progress enables firms to substitute labour specialised in routine tasks (middle of the wages scale a priori) by capital. Workers specialised in manual non routine tasks with the lowest stock of skills, and workers specialised in conceptualisation and intellectual tasks with a high stock of skills, are therefore relatively fostered by the impulse of technologies, implying a skill polarisation of labour market. Obviously, the polarisation cannot be directly observed in this study since there are only two levels of skill in the NEMESIS model. However, if we try to identify this polarisation with the help of a sectorial analysis, we notice that construction and lodging and catering sectors with low-skilled workers doing manual non-routine tasks, are also the only NEMESIS sectors creating both high-skilled and low-skilled jobs. In addition, they have the lowest average wage for low-skilled employment, which could confirm that low-skilled workers of these sectors have a very low skill endowment. These results provide then a good insight on skill polarisation.

[21] This typology is valid for capital as well as labour. Please refer to appendix for NEMESIS sectorial mapping.

Table 4.2: European unemployment rates

	2010	Friendly - 2030	Tough -2030
Total unemployment	9.7%	7.7%	11.8%
High-skilled unemployment	5.6%	7.0%	10.5%
Low-skilled unemployment	11.2%	8.1%	12.4%

Source: Historical data Eurostat (2012 [29]), NEMESIS model

In the "Friendly" scenario, labour supply of high-skilled is strongly increasing. This important increase in high-skilled labour force supply cannot be fully absorbed by labour demand. Indeed, the increase in productivity and the cost and price reductions that follow are unable to raise enough labour demand. Furthermore, wage rigidities prevent the adjustment to equilibrium in the labour market of the high-skilled workers. In the modelling works, these results could also be explained by the hypothesis of constant R&D intensity. Economic literature has shown the complementarity between different forms of intangible assets (*e.g.* Bresnahan *et al.*, 2002 [7], Brynjolfsson *et al.*, 2002 [8], Cummins, 2004 [15] or Lev and Radhakrishnan, 2005 [44]). Thus, higher research and innovation investments could increase skills needs. These observations plead for R&D and innovation policy measures. In the NEMESIS model, these mechanisms could be implemented in future EU response scenarios.

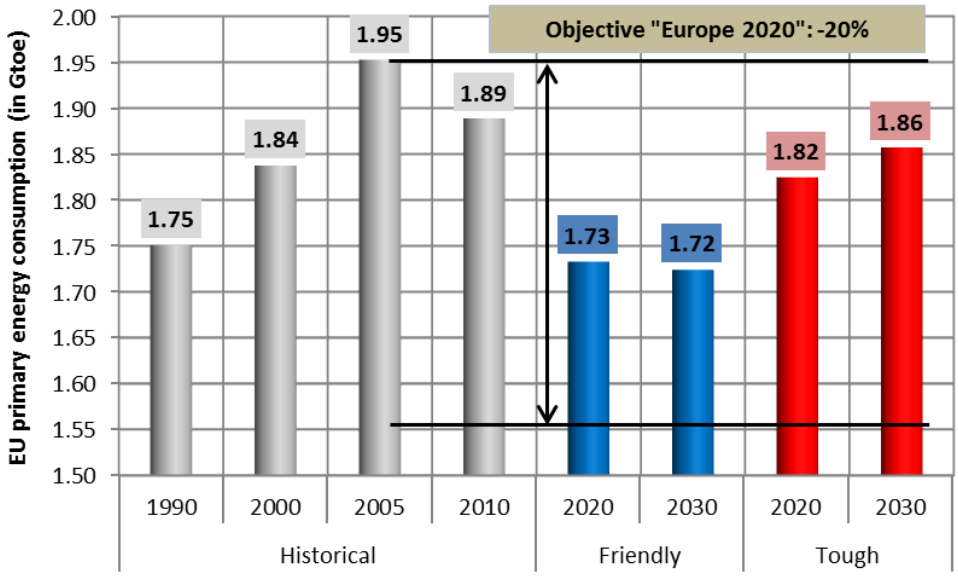
5 A first step towards a successful transition in the "Friendly" scenario

After the analysis of economic results for both scenarios, it is necessary to display and analyse the energy and environmental (*i.e.* GHG emissions) results to complete the description of the socio-ecological transition context (still in the framework of no policy response). Overall, both scenarios are distinguished by two different economic pathways up to 2030 which are the main drivers of the energy consumption in the NEMESIS model. Nevertheless, for energy and environment these scenarios have also been distinguished by different efficiency gains even if R&D intensity is supposed to be constant. The first part of this section will regard to European energy consumption and the second part will look at greenhouse gases emissions. The section will be concluded by a summary of the main findings.

5.1 The "Friendly" context enables a decoupling between economic growth and energy consumption

The first figure on energy shows the European primary energy consumption pathways in both scenarios (see figure 5.1). It highlights the intensity of energy transition according to the scenario. In the "Friendly" scenario, the European primary energy consumption passes from 1.9 Gtoe in 2010 to 1.7 Gtoe in 2020 and 2030 whereas it reaches 1.8 Gtoe and 1.9 Gtoe in the "Tough" scenario. As the European economy growth in the "Tough" scenario is significantly weaker than in the "Friendly" scenario and the energy prices are higher in the "Tough" scenario, it was expected, *ceteris paribus*, a lower energy consumption in the "Tough" scenario. This result emphasises the main divergence between both scenarios.

Figure 5.1: European primary energy consumption

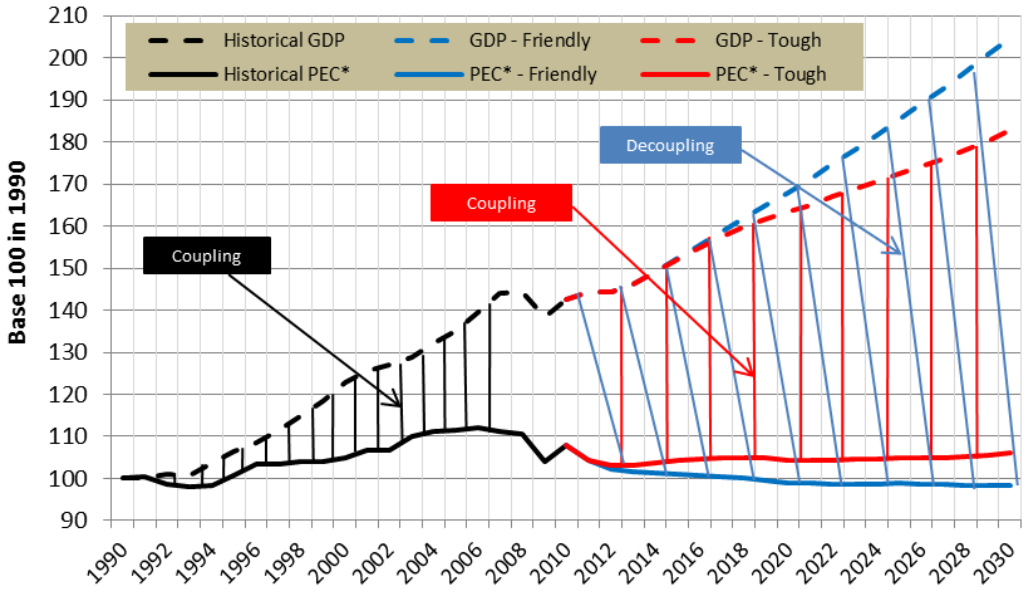


Source: Historical data authors calculation (based on Eurostat, 2012 [27]), NEMESIS model.

The "Friendly" scenario is characterised by a speeding up of energy efficiency gains compared to past trends. During the whole period (2010-2030), the European average energy efficiency gains (relative to GDP) is about 2.2% per year while it was about 1.3% per year between 1990 and 2005. In the "Tough" scenario, energy efficiency remains stable with 1.3% per year. Thus, **the "Friendly" scenario is moving towards an energy transition** with accelerated energy efficiency whereas **"Tough" scenario does not take the path of energy sobriety**. In fact, the sustained European economic growth combined with an environmental awareness of European society allows the implementation of energy-saving investments in the "Friendly" whereas in the "Tough" scenario these investments are not implemented or implemented at a lesser extent.

Now, regarding the "Europe 2020" targets of 20% increase in energy efficiency (EC, 2011 [20]), none of the scenarios reaches the targets in 2020. Indeed, European Commission has decided to measure this indicator with the level of primary energy consumption compared to 2005. In this case, the European Union target (-20%) is not reached with -11% in 2020 compared to 2005 in the "Friendly" scenario and -6.5% in the "Tough" one. Nevertheless, regarding the energy efficiency (relative to GDP) in the "Friendly" scenario, it increases by 29% between 2020 and 2005.

Figure 5.2: European GDP and primary energy consumption



*: PEC = Primary Energy Consumption

Source: Historical data authors calculation (based on Eurostat, 2012 [27] and EC, 2012 [23]), NEMESIS model

Another notable point in the dynamic of energy consumption between scenarios is the beginning of a decoupling[22] of economic growth from energy consumption in the "Friendly" scenario[23]. Indeed,

[22] We are defining the decoupling as a situation where the evolution of the indicators is diverging and the coupling when they change in the same direction even if it is at a different speed.

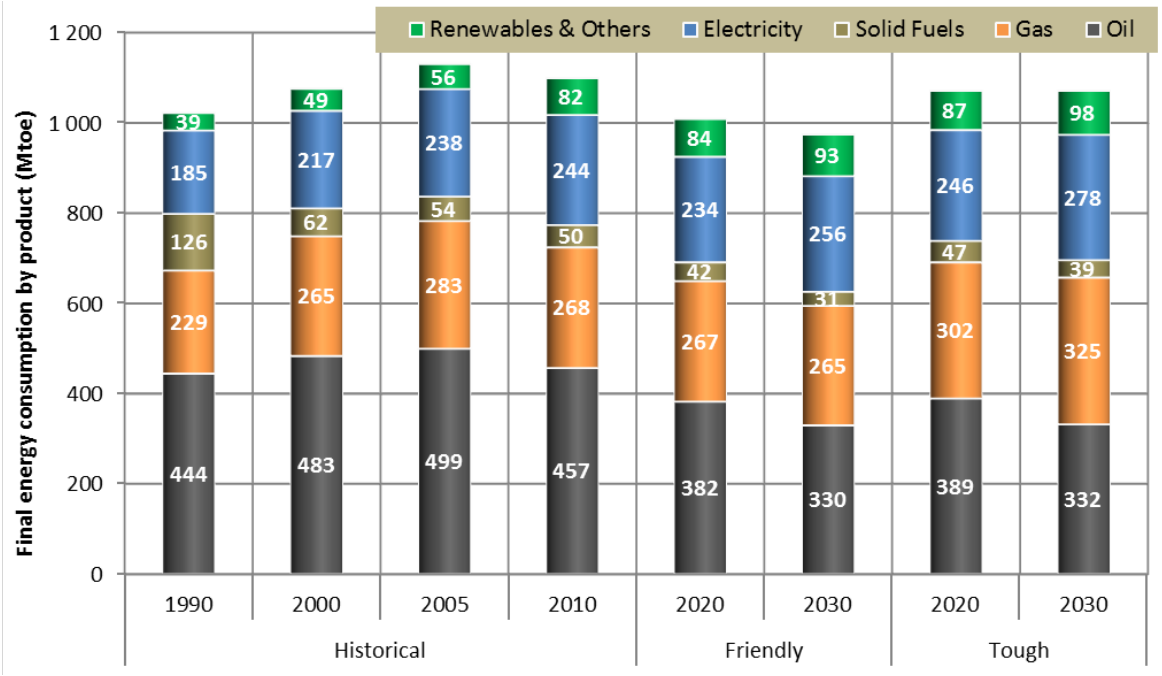
[23] See *e.g.* UNEP (2011 [54]) for an analysis resources decoupling.

figure 5.2 shows the evolution of European GDP and European primary energy consumption between 1990 and 2030 for both scenarios. Historical data shows a weak coupling of primary energy consumption and economic growth, a statement still valid in the "Tough" scenario but not in the "Friendly" one. Despite sustained economic growth **in the "Friendly" scenario, the relatively high energy efficiency gains allow the emergence of a weak decoupling** between economic growth and energy consumption. At the end of the period, energy consumption decreases by -0.07% per year whereas European GDP growth at 2%. This result of a weak decoupling between economic growth and energy consumption in the "Friendly" scenario is a promising result. It reveals that, even without strong policies, a dynamic with both economic growth and energy sobriety is possible. Policies that would strongly enhance investments in energy efficiency should then enable a real energy transition.

5.2 Fossil fuels loss ground

Analysing the evolution of **European final energy consumption by product** (see figure 5.3) reveals a decrease of oil consumption in both scenarios in 2030. The European final consumption of oil decreases from 460 Mtoe in 2010 to 330 Mtoe in 2030 in both scenarios. Its share in the European energy mix passes from 41.5% in 2010 to 34% in the "Friendly" scenario and 31% in the "Tough". The fall of oil share in consumption is explained by an increase of oil price from US$78 ($ constant 2010) in 2010 to US$117 and US$195 in the "Friendly" and "Tough" scenarios respectively *(i.e.* +50% and +150% respectively) whereas oil price has already increased by 44% between 2005 and 2010.

Figure 5.3: European final energy consumption by product

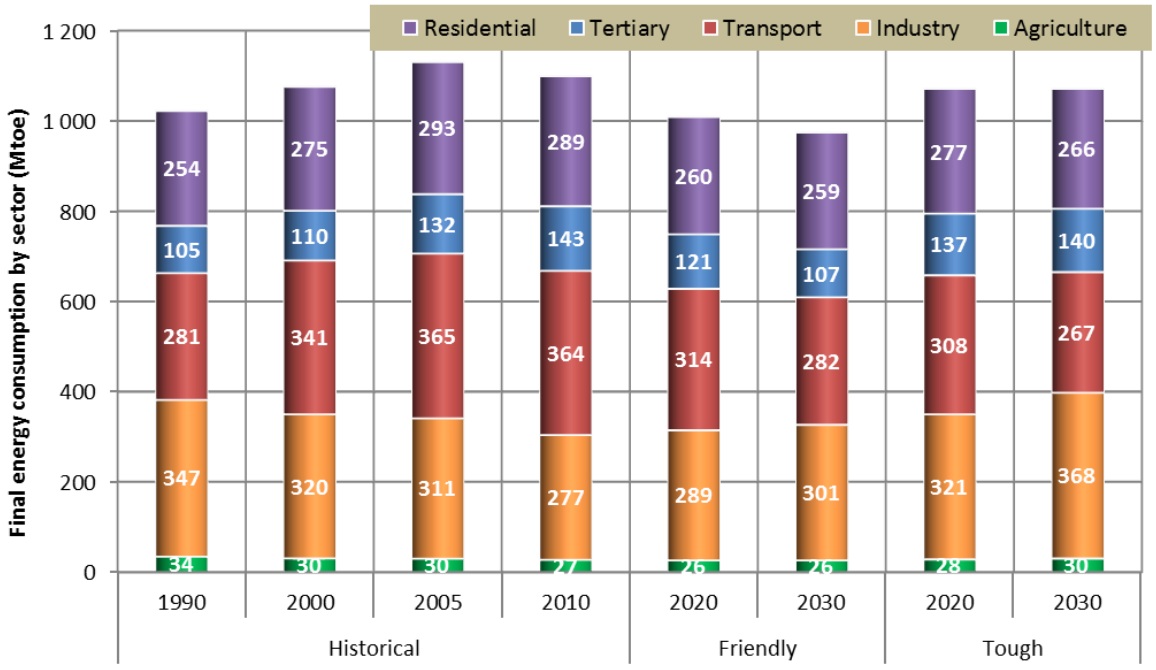


Source: Historical data authors calculation (based on Eurostat, 2012 [27]), NEMESIS model.

The higher oil price in the "Tough" scenario explains its weaker share in the European final energy consumption despite lower energy efficiency gains. The gas final consumption is relatively stable in the "Friendly" scenario whereas it rises by about 58 Mtoe in the "Tough". Thus, **fossil fuels final consumption is decreasing in both scenarios** but at a lesser extent in the "Tough" than in the "Friendly" scenario with -78 Mtoe and almost -150 Mtoe (*i.e.* -20% compared to 2010) in the "Friendly" scenario.

Electricity consumption in EU is expected to increase in both scenarios with +12 Mtoe and +34 Mtoe in the "Friendly" and "Tough" scenarios respectively. Indeed the electrification of final energy consumption continues. Historically, electricity consumption in Europe has grown from 2 150 TWh to 2 850 TWh between 1990 and 2010 (*i.e.* a third more in two decades). The growth of specific electricity consumption (domestic electrical, ICT, data center, etc) remains relatively important. Finally, renewable and others products final consumption also increases in both scenario by about +11 Mtoe in the "Friendly" and +16 Mtoe in the "Tough". Nevertheless, the growth of renewable energy remains weak and the "Europe 2020" target (EC, 2011 [20]) of about 20% of energy from renewable in 2020 is not reached. The share is about 16.8% in 2020 in the "Friendly" scenario and 16.5% in the "Tough" scenario. The 20% target is reached in 2028 in the "Friendly" scenario and in 2029 in the "Tough".

Figure 5.4: European final energy consumption by sector



Source: Historical data authors calculation (based on Eurostat, 2012 [27]), NEMESIS model.

The last analysis of European energy consumption will look at the **evolution by sector** (see figure 5.4). All sectors (expect industry sectors) reduce their final energy consumption in the "Friendly" scenario and residential, tertiary and transports also reduce their energy consumption in the "Tough" scenario. In the residential, the final energy consumption is decreasing by 30 Mtoe and 23 Mtoe in the

"Friendly" and "Tough" scenario respectively. The rise of energy cost in both scenarios but especially in the "Tough" one, favours the financial returns of energy efficiency expenditures for households. Thereby, households make these investments and consequently diminish their energy consumption especially for heating. This reduction of European household final energy consumption is mainly due to a lesser use of heating oil and at lesser extent gas whereas electricity consumption tends to increase. These figures are relatively similar in tertiary sectors but with a stronger energy efficiency (-36 Mtoe) in the "Friendly" scenario than in the "Tough" (-3 Mtoe).

In transport sector, efficiency gains are substantial with -82 Mtoe in the "Friendly" scenario and -97 Mtoe in the "Tough" (*i.e.* -22% and -27% respectively). The absolute gains are relatively similar in both scenario but it hides different explanations. For instance, in the inland transports sectors, energy efficiency (compared to value added) gains are about 5.6% per year in the "Friendly" scenario whereas they are about 3.3% in the "Tough". So, the final energy consumption fall in the "Friendly" scenario comes from high enhancement in vehicle engine and in the logistic process. In the "Tough" scenario, this fall is doubly explained by *(i)* underlying energy efficiency gains and *(ii)* a weak growth of the transport sectors (also including non-commercial uses). Besides, the share of biofuel in gasoline remains weak with 4.1% in 2020 and 4.6% in 2030 in both scenarios. Furthermore, European agriculture remains highly energy dependent in both scenarios, even if this dependency tends to slightly decrease in the "Friendly" scenario.

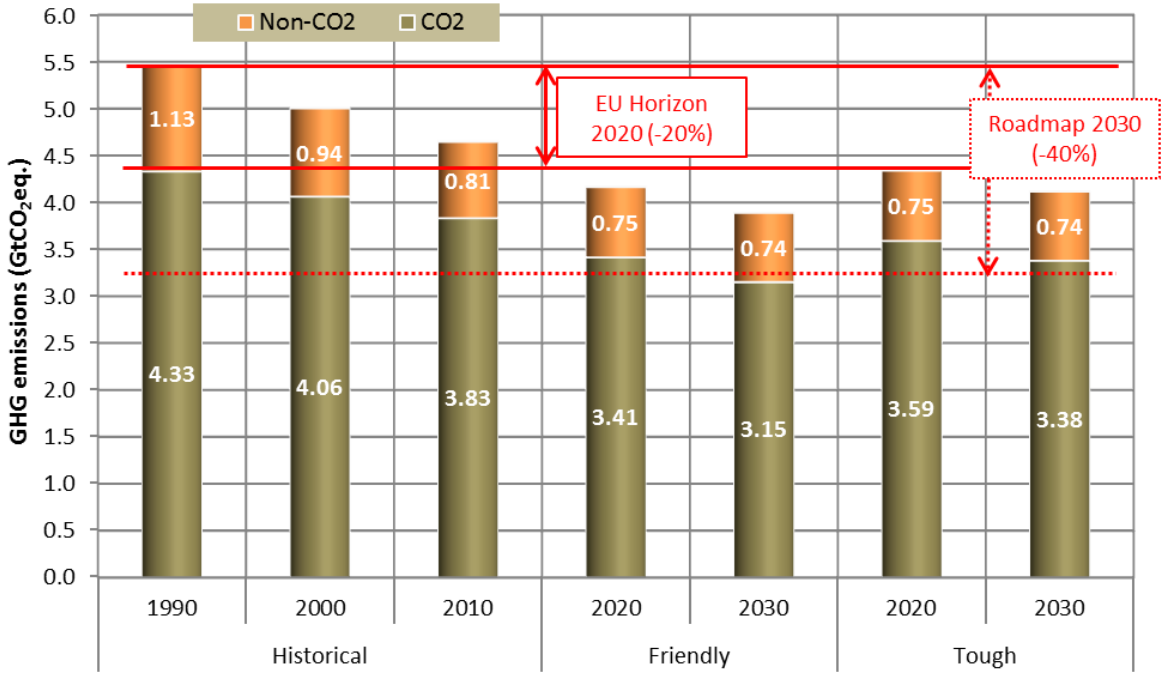
Finally, industry is the only sector with low energy efficiency gains in both scenarios. Indeed, potential energy efficiency gains are more difficult to find, especially in the energy intensive industries such as steel, float glass or clinker. Efficiency gains remain limited in both scenarios with 1.6% per year in the "Friendly" scenario and none in the "Tough" scenario. Higher energy efficiency gains could then be found in industry but only with important investments in research and development.

5.3 Still some efforts to reach the European pathway for 2°C target

The last results analysis will look at greenhouse gas emissions (GHG)[24]. The analysis will be examined in the light of European climate change mitigation policies. Figure 5.5 displays the GHG emissions from 1990 to 2030 in each scenario. In the "Friendly" scenario the European GHG emissions are about 4.16 $GtCO_2eq.$ in 2020 and 3.89 $GtCO_2eq.$ in 2030. These changes correspond to a fall of about -23.7% and -28.8% in 2020 and 2030 respectively compared to 1990. European CO_2 emissions decrease by 21.1% in 2020 and 27.3% in 2030 compared to 1990. In the "Tough" scenario, total European GHG emissions are reduced from 4.65 $GtCO_2eq.$ in 2010 to 4.34 $GtCO_2eq.$ in 2020 and 4.12 $GtCO_2eq.$ in 2030 *i.e.* -20.5% and -24.6% compared to 1990 respectively.

[24]The non-CO2 emissions projection comes from the baseline scenario of Hoglung-Iskasson *et al.* (2010 [36]) that realised projections for the Directorate-General for Climate Action of the European Commission.

Figure 5.5: Greenhouse gases emissions



Source: Historical data (EEA, 2012 [24]), CO_2 NEMESIS model and non-CO_2 (Hoglund-Iskasson *et al.*, 2011 [36])

Regarding the European climate change mitigation policy objectives, two conclusions emerge. First, in both scenarios, the EU climate and energy package objective of **-20% of GHG emissions in 2020 compared to 1990** (EP, 2009) **is reached**. The reduction is about 23% in the "Friendly" scenario and 20.5% in the "Tough". This reduction of European GHG emissions mainly comes from the reduction of CO_2 emissions resulting in the reduction of fossil energy consumption, as analysed in the previous section. Nevertheless, regarding the European road map to keep climate change below 2°C (EC, 2011 [19]) which reaches a reduction between 80-95% in 2050 compared to 1990, the GHG emissions reduction in each scenario remains too weak. Indeed in the road map, the emissions pathway to 2050 passes by -25% in 2020 and -40% in 2030. Even if the -25% target in 2020 is almost achieved in the "Friendly" scenario, the **GHG emissions reduction of 40% in 2030 is far from being reached in both scenarios**.

Finally, it is interesting to look at the member states' efforts by considering the evolution of GHG emissions per capita in each European country. Table 5.1 shows that the efforts in terms of GHG emissions per capita by members states are relatively heterogeneous. In 1990 as well as in 2005, Luxembourg was the biggest European emitter with 33.8 t/cap and 28.1 t/cap respectively and it remains with 22.3 t/cap in 2030 in the "Friendly" and 23.4 t/cap in the "Tough". At the opposite end, Sweden, relatively virtuous in 1990 with 8.5 t per inhabitant is also one of the most virtuous in 2030 with 5 t/cap in 2030 *i.e.* -40% compared to 1990.

Table 5.1: EU27 greenhouse gases emissions per capita ($tCO_2eq./cap.$)

			Friendly			Tough		
	1990	2005	2030	Ev° /90	Ev° /05	2030	Ev° /90	Ev° /05
AT	10.2	11.3	9.3	→ -9%	↘ -18%	10.0	→ -3%	↘ -12%
BE	14.4	13.7	12.5	→ -13%	→ -9%	14.0	→ -3%	→ 2%
CZ	18.9	14.3	11.1	↓ -41%	↘ -23%	11.7	↓ -38%	↘ -19%
DE	15.8	12.1	9.3	↓ -41%	↘ -23%	10.3	↓ -35%	↘ -15%
DK	13.4	11.8	7.6	↓ -43%	↓ -36%	8.3	↓ -38%	↓ -30%
EE	26.0	13.8	19.3	↘ -26%	↑ 40%	21.4	↘ -18%	↑ 55%
ES	7.3	10.1	7.1	→ -2%	↘ -30%	7.4	→ 1%	↘ -27%
FI	14.1	13.1	8.7	↓ -38%	↘ -34%	9.7	↓ -31%	↘ -26%
FR	9.9	9.3	6.2	↓ -37%	↘ -33%	6.6	↓ -33%	↘ -29%
GR	10.4	12.2	6.7	↘ -35%	↓ -45%	6.8	↓ -34%	↓ -44%
HU	9.4	7.9	5.7	↓ -40%	↘ -28%	5.9	↓ -38%	↘ -26%
IE	15.7	16.9	9.5	↓ -40%	↓ -44%	9.7	↓ -38%	↓ -43%
IT	9.1	9.8	6.5	↘ -29%	↘ -34%	7.0	↘ -24%	↘ -29%
LT	13.4	6.7	6.2	↓ -54%	→ -7%	6.7	↓ -50%	→ 1%
LU	33.8	28.1	22.3	↘ -34%	↘ -20%	23.4	↓ -31%	↘ -17%
LV	9.9	4.9	5.4	↓ -45%	↗ 11%	5.5	↓ -44%	↗ 14%
MT	5.8	7.5	4.3	↘ -25%	↓ -42%	4.2	↘ -26%	↓ -44%
NL	14.2	12.9	9.9	↘ -30%	↘ -23%	10.5	↘ -26%	↘ -18%
PL	12.0	10.2	9.7	↘ -20%	→ -5%	9.9	↘ -17%	→ -2%
PT	6.0	8.2	5.0	↘ -17%	↓ -39%	5.1	↘ -15%	↓ -38%
RO	10.9	6.9	7.7	↘ -29%	↗ 12%	7.2	↓ -34%	→ 5%
SE	8.5	7.5	5.0	↓ -41%	↘ -32%	5.2	↓ -39%	↓ -30%
SI	9.2	10.2	5.9	↓ -36%	↓ -42%	6.4	↓ -31%	↓ -37%
SK	13.6	9.5	8.0	↓ -41%	→ -15%	8.5	↓ -37%	↘ -10%
UK	13.4	10.9	6.1	↓ -54%	↓ -44%	6.6	↓ -50%	↓ -39%
CY	11.3	14.8	8.2	↘ -27%	↓ -44%	7.6	↓ -33%	↓ -49%
BG	13.0	8.5	10.4	↘ -21%	↗ 21%	8.2	↓ -37%	→ -4%
EU	11.6	10.4	7.7	↘ -34%	↘ -26%	8.1	↓ -30%	↘ -22%

Source: Historical data (EEA, 2012 [24] and AMECO, 2012 [23]), NEMESIS model for CO_2 and Hoglund-Iskasson *et al.* (2010 [36]) for non-CO_2.

6 The gap with European objectives and the reliability of the exercise

The model can be considered as a "compass" that indicates the direction of the path followed up by the European countries. Is this path compatible with the Europe targets? Is the direction indicated by the compass reliable? We intend to give some insights to these questions by comparing our results to the Europe targets and our employment forecasts to other exercices in order to test the results robustness.

6.1 Europe 2020 targets and beyond

Table 6.1 enumerates the "Europe 2020" targets (EC, 2011 [20]) for which the NEMESIS model can provide insights.

Table 6.1: A matching of "Europe 2020" targets

				Friendly		Tough	
	2005	2010	"Europe 2020" target	2020	2030	2020	2030
Employment rate*	68.0%	68.6%	75.0%	69.8%	73.8%	68.6%	68.2%
Gross domestic expenditures on R&D[(a)]	1.82%	2.01%	3.00%	2.01%	2.01%	2.01%	2.01%
Greehouse gas emissions (index 100 in 1990)***	92	85	80	76	71	79	75
Share of renewable energy in gross final energy consumption	8.5%	12.5%	20.0%	16.8%	21.0%	16.5%	20.5%
Primary energy consumption** (Gtoe)	1.95	1.89	1.56	1.73	1.72	1.82	1.86

[(a)]: R&D intensity is assumed to constant (by scenario definition)
*: Calculated as the ratio between total employment and total population between 15 and 64 years old.
**: Level can be different from Eurostat due to differences in primary energy accounting.
***: EU Road map milestone at -40% in 2050 compared to 1990 (EC, 2011 [19]).
Source: Historical data (Eurostat, 2012 [28]), NEMESIS model

The first indicator, the European employment rate, is targeted at 75% in 2020. No scenario reaches this level, either in 2020 or in 2030, even if employment rate in 2030 in the "Friendly" scenario is almost equal to 75% with 73.8%. This mismatch of the "Europe 2020" target raises the following questions: how could this target be attained? Moreover, as identified previously, unemployment rate remains relatively high in 2030 at 7.7%, despite substantial employment creation in the "Friendly" scenario, with almost 20 million new jobs. The rise of new high-skilled labour supply cannot be fully absorbed by job creations. Therefore, the reinforcement of job creations by structural policies such as **R&D and innovation support policies** could help to reach the target. This is confirmed by the second "Europe 2020" target, R&D intensity that has been assumed to be constant in both scenarios. Thus,

reaching the 3% target will certainly significantly increase employment within the EU in the short and long-term. In addition, policies aiming to **raise the labour market participation** (such as enhancement of women or elderly labour participation) will also be necessary to match the 75% target in 2020. Both kinds of structural European policies will ensure the achievement of the employment rate target in 2020.

"Europe 2020" environmental targets are not all achieved. As presented in the previous section, the -20% of GHG emissions reduction in 2020 compared to 1990 is reached in both scenarios but the resource efficiency and the renewable targets are not. Furthermore, although the GHG emissions objective is fulfilled in the "Tough" scenario, this success is due to a weak economic growth. Is a satisfactory environmental achievement with a high employment cost a desirable situation? Besides, GHG emissions results of both scenarios do not respect the 2030 milestone of the "Roadmap to 2050" of about -40% compared to 1990 (EC, 2011 [20]). Therefore, **reinforcing the European climate change mitigation policy** could help to accomplish the environmental and energy targets. For instance, introducing an European carbon tax in the non EU-ETS sector or **resource efficiency policy** (energy-saving investments supports, raising of environmental standard and even recycling policies) could be implemented. Furthermore, implementing some harmonised European policies to support renewable energy development will allow for the achievement of renewable target. It will also help the European Union, in addition to policies proposed above, to follow the pathway towards limiting climate change to 2°C increase. Finally, environmental and energy objectives are strong challenges for Europe up to 2030 and they are not necessarily contradictory with the European economic and social challenges (innovation, resource efficiency policies, etc).

6.2 Are projections reliable?

There are numerous studies on economic or energy-environment medium-term projection, whereas integrated and detailed projections for the European Union remain limited. And in order to focus on the main topic of this paper, we will consider the employment projections up to 2020 and confront them with the skills forecast of the CEDEFOP (2012 [11])[25]. The aim is not to establish a hierarchical classification between both projections, but regarding the knowledge and experience of CEDEFOP on these kinds of projections, it is useful to compare aggregated figures.

Table 6.2 compares the evolution between 2010 and 2020 of the CEDEFOP skills forecasts and European employment projections by level of skill in both scenarios[26]. Surprisingly, the projections of European employment are very close between the CEDEFOP skills forecasts and the "Friendly" scenario, with an increase between 13.5 and 14 million of high-skilled jobs and a decrease between 5 and 6 million in low-skilled employment. In the "Tough" scenario, the figures are more different even if they are moving in the same direction. Thereby, the table 6.2 confirms **the 'skillisation' of the future European employment** and **the unappeasable process of low-skilled job destruction**.

[25] Interested readers could also look at *e.g.* EC (2012 [21]), OECD (2012 [50]), EC (2012 [18]), EC (2012 [22]) or McKinsey (2012 [46]) for economics and employment or EC (2009 [17]), IEA (2012 [39]) or EIA (2012 [26]) for energy and environment.

[26] In 2010, the level could be different between CEDEFOP (2012 [11]) and NEMESIS model.

Table 6.2: Comparison of European skills employment projections with CEDEFOP skills forecast

	CEDEFOP*		Friendly		Tough	
	Level change (2010-2020)	% change (2010-2020)	Level change (2010-2020)	% change (2010-2020)	Level change (2010-2020)	% change (2010-2020)
High qualification	13 535	20.0%	13 936	22.0%	7 203	11.4%
Medium & Low qualifications	-5 158	-3.2%	-5 734	-3.6%	-3 595	-2.2%
All qualifications	8 377	3.6%	8 202	3.7%	3 608	1.6%

*: Data extract on January 2013
NB: Level of employment in 2010 could be different between CEDEFOP and NEMESIS model
Source: CEDEFOP (2012 [11]), NEMESIS model.

Table 6.3 allows to go further in the details by comparing CEDEFOP skills forecast for European sectorial employment with both scenarios[27]. As observed previously, the total employment in the CEDEFOP skills forecast and the "Friendly" scenario are very close. Nevertheless, regarding sectorial employment changes, it appears that the evolution remains relatively similar even if some differences emerge.

Table 6.3: Comparison of European sectorial employment projections with CEDEFOP skills forecast

	CEDEFOP*		Friendly		Tough	
	Level change (2010-2020)	% change (2010-2020)	Level change (2010-2020)	% change (2010-2020)	Level change (2010-2020)	% change (2010-2020)
Primary sector & utilities	-1 486	-10.1%	-1 700	-12.1%	-1 735	-12.3%
Manufacturing	-456	-1.3%	-2 336	-6.6%	-2 428	-6.9%
Construction	215	1.3%	3 040	18.9%	3 033	18.8%
Distribution & transport	3 486	5.9%	1 569	2.8%	1 542	2.7%
Business & other services	5 720	11.1%	7 698	19.8%	6 360	16.3%
Non-marketed services	897	1.7%	-69	-0.1%	-3 164	-5.1%
All industries	8 377	3.6%	8 202	3.7%	3 608	1.6%

*: Data extract on January 2013
NB: Level of employment in 2010 could be different between CEDEFOP and NEMESIS model
Source: CEDEFOP (2012 [11]), NEMESIS model.

[27]Mapping between NEMESIS sectors and CEDEFOP ones is available on appendix.

In the primary & utilities sector, the high productivity gains remain. The employment in this sector is expected to decrease between 10% and 12.5%. Employment in the manufacturing sector is supposed to be reduced between 0.5 and 2.5 million. This decrease is supposed to be stronger in our scenarios than in the CEDEFOP one. In distribution and transport sector, the three cases provide increasing employment with more than 3.5 million for CEDEFOP and around 1.5 million in the "Friendly "and "Tough" scenarios. The business & other services sector exhibits large employment creation in the three projections. In addition, non-market services is supposed to create less than 1 million jobs (*i.e.* +1.7%) whereas it is stable in the "Friendly" scenario and decreasing in the "Tough" with -3 million. Indeed, the public finance consolidation following the sovereign debt crisis limits job creations in this sector, all the more in the "Tough" scenario where the public finance crisis is continuing. Finally, the largest differences in the employment dynamics come from the construction sector, for which "Friendly" and "Tough" scenarios expect substantial employment gains whereas the CEDEFOP projection counts on relative stability. This could perhaps reveal a certain overestimation of employment creation within the construction sector in both scenarios. Nevertheless, some elements such as investments rebound, low employment productivity and the rise of the energy renovation activities which are labour intensive are insights on the potential employment creation within the construction sector.

Thereby, the comparison of CEDEFOP European sectorial employment projections with both scenarios of this study emphasises our two main results which are *(i)* the 'skillisation' of the European employment and *(ii)* the **continued 'tertiarisation' of European employment**. However, this shift towards services instead of industrial sectors is slightly more important in the "Tough" and "Friendly" than in the CEDEFOP skills forecast.

7 Concluding remarks

7.1 Summary

In the "Friendly" scenario, the main opportunities come from the labour force increase with a large rise in high-skilled labour supply. This growth of labour force boosts the European long-term potential growth. In addition, the relatively favourable natural and financial conditions existing in the "Friendly" scenario lead to a lasting European economic growth (about 2% after the European sovereign debt crisis recovery). This released European economic growth allows for the creation of almost 20 million jobs over two decades. The low-skilled unemployment rate is reduced from 11% in 2010 to 8% in 2030. Nevertheless, the high-skilled unemployment rate is slightly increasing, passing from 5.5% in 2010 to 7% in 2030. Bottlenecks appear for high-skilled workers, as their additional productivity cannot be absorbed by an equivalent demand (besides wage rigidities delay the return to the equilibrium of the labour market).

The "Tough" scenario with less long-term potential growth and less favourable financial and natural conditions gives at the end of the period, an economic growth barely superior to 1%, with a total unemployment rate increasing to 12% and striking all categories. The economic growth rates among EU27 countries are relatively contrasted. This heterogeneity mostly results from initial public finance balance. Economic growth inequity is reinforced by the bad financial conditions increasing the general government debt burden. This may prevent some countries from implementing sufficient public policies towards a successful socio-ecological transition.

In both scenarios, deindustrialisation and 'tertiarisation' processes of European economy are still occurring but at a slower rate. Economic growth, after the recovery period (2010-2015), comes from European internal demand. External balance is no longer a driver for European economy. In the "Friendly" scenario, the engine of economic growth is the private and public consumptions whereas, in the "Tough" scenario in which internal demand is weak, external balance may give a positive contribution to economic growth. Employment dynamics comes from high-skilled job supply that increases by 32 million in the "Friendly" scenario and by 11 million in the "Tough" one. It confirms the "skillisation" of European employment already identified in the literature. Besides, low-skilled employment is decreasing by 12.5 million in the "Friendly" scenario and 17.5 million in the "Tough". This process of low-skilled jobs destruction seems then non-reversible. Nevertheless, the high rate of job creations for high-skilled cannot prevent an increase of unemployment.

This study emphasises two main messages *(i)* difference in labour force evolutions as well as human capital accumulation are defining the medium and long-term potential economic growth of the different EU countries and *(ii)* sovereign debt burden will also constrain economic growth especially if long-term potential growth remains weak. It is the case in the "Tough" scenario where human capital and labour force developments are not sufficient to assure a high long-term potential economic growth. Thus, the stabilisation of public debt requires additional adjustments which reinforces the slowing down of the European economic activities by a "snowball" effect.. Thereby, the "Tough" scenario does not take the pathway towards a successful the socio-ecological transition, due to a lack of investment supports whereas in the "Friendly" scenario, the socio-ecological transition can start, thanks to an economic situation in which financing of required investments can be found more easily.

The energy consumption diagnostics in both scenarios could be fairly examined in the light of the European policy objectives such as "Europe 2020" targets (EC, 2011 [20]) or more long term policy objectives such as European Roadmap for low carbon economy (EC, 2011 [19]). Starting from the Europe 2020 objectives of raising resource efficiency by 20% in 2020, none of the scenarios reaches this objective. The largest reduction occurs in the "Friendly" scenario with -11% in 2020. Nevertheless, a historical break in resources efficiency appears in the "Friendly" scenario. Indeed, comparing the evolution of European GDP and European primary energy consumption, there is a weak but complete decoupling between energy consumption and economic development. Furthermore, the objective of European GHG emissions reduction by 20% in 2020 compared to 1990 is reached in both cases, with -24% and -21% in the "Friendly" and "Tough" scenarios respectively. However, considering more stringent and long-term objectives presented in the European GHG reduction roadmap, there is a strong environmental challenge since these objectives are not respected. Indeed, the GHG emissions reduction in 2030 compared to 1990 is about 29% in the "Friendly" scenario and 25% in the "Tough" one although the roadmap asks for a reduction of about 40%. Therefore, the pathway towards a low carbon economy in 2050 is not taken in both reference scenarios.

7.2 EU policy responses for a successful socio-ecological transition

As established in the previous section, the "Europe 2020" that gives EU the objective to become a "*smart, sustainable and inclusive economy*" and materialised by quantitative targets, is not attained in both scenarios. These difficulties to meet the "Europe 2020" targets challenge EU policy-makers. Three kinds of policy could be adapted to tackle these difficulties. On the one hand, financial reforms would help the EU break free from financial constraints and to encourage European economic growth, although the "Tough" scenario shows that a too strong financial consolidation combined with unfavourable demographic and natural conditions would induce both lasting weak economic growth and high unemployment. These kinds of policy responses are out of the scope of this analysis. On the second hand, innovation, research or competitiveness policies can tackle both employment and environmental difficulties encountered in the reference scenarios. For instance, the relatively high-skilled unemployment rate may be reduced by these new policies. The increase of intangible capital (economic competencies, ICT, organisational capital, etc.) should also come together with support policies for innovation and research. Finally, structural policies for resource efficiency and climate change (*e.g.* carbon tax, energy-saving investments supports or rising of environmental standards) are necessary for the pathway towards a successful socio-ecological transition.

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Appendix

Abbreviation

- CEEC: Central and Eastern Europe
- CO_2: Carbon dioxide
- EU: European Union
- EU-ETS: European Union Emissions Trading System
- GDP: Gross domestic product
- GHG: Greenhouse gas
- OADR: Old Age Dependency Ratio (ratio between persons aged 65 years and over compared with persons 15-64 years old)
- R&D: Research and development
- SET: Socio-ecological transition
- toe: Ton of oil equivalent
- USA: United States of America

Nomenclature and Mapping

Table 7.1: EU27 nomenclature

AT	Austria	**IT**	Italy
BE	Belgium	**LT**	Lithuania
BG	Bulgaria	**LU**	Luxembourg
CY	Cyprus	**LV**	Latvia
CZ	Czech Republic	**MT**	Malta
DE	Germany	**NL**	Netherlands
DK	Denmark	**PL**	Poland
EE	Estonia	**PT**	Portugal
ES	Spain	**RO**	Roumania
FI	Finland	**SE**	Sweden
FR	France	**SI**	Slovenia
GR	Greece	**SK**	Slovakia
HU	Hungary	**UK**	United-Kingdom
IE	Ireland		

Table 7.2: Exposed and less-exposed sectors mapping

	Exposed	Less-exposed
1 Agriculture		X
2 Coal and Coke	X	
3 Oil & Gas Extraction	X	
4 Gas Distribution		X
5 Refined Oil	X	
6 Electricity		X
7 Water Supply		X
8 Ferr & non Ferrous Metals	X	
9 Non Metallic Min Products	X	
10 Chemicals	X	
11 Metal Products	X	
12 Agr & Indus Machines	X	
13 Office machines	X	
14 Electrical Goods	X	
15 transport Equipment	X	
16 Food. Drink & Tobacco		X
17 Tex.. Cloth & Footw.	X	
18 Paper & Printing Products	X	
19 Rubber & Plastic	X	
20 Other Manufactures	X	
21 Construction		X
22 Distribution		X
23 Lodging & Catering		X
24 Inland Transports		X
25 Sea & Air Transport	X	
26 Other Transports		X
27 Communication		X
28 Bank. Finance & Insurance		X
29 Other Market Services		X
30 Non Market Services		X

Table 7.3: Mapping for sectors classification by technological advancement

	Low-tech	Medium-Tech	High-Tech
1 Agriculture		X	
2 Coal and Coke		X	
3 Oil & Gas Extraction		X	
4 Gas Distribution		X	
5 Refined Oil		X	
6 Electricity			X
7 Water Supply		X	
8 Ferr & non Ferrous Metals		X	
9 Non Metallic Min Products		X	
10 Chemicals			X
11 Metal Products		X	
12 Agr & Indus Machines			X
13 Office machines			X
14 Electrical Goods			X
15 transport Equipment			X
16 Food. Drink & Tobacco	X		
17 Tex.. Cloth & Footw.	X		
18 Paper & Printing Products	X		
19 Rubber & Plastic		X	
20 Other Manufactures	X		
21 Construction		X	
22 Distribution	X		
23 Lodging & Catering	X		
24 Inland Transports		X	
25 Sea & Air Transport		X	
26 Other Transports	X		
27 Communication			X
28 Bank. Finance & Insurance			X
29 Other Market Services			X
30 Non Market Services		X	

Table 7.4: Mapping between CEDEFOP skills forecast and NEMESIS sectors

	Primary & utilities	Manuf.	Const.	Distrib. & transp.	Business & other serv.	Non-mark. serv.
1 Agriculture	X					
2 Coal and Coke	X					
3 Oil & Gas Extraction	X					
4 Gas Distribution	X					
5 Refined Oil		X				
6 Electricity	X					
7 Water Supply		X				
8 Ferr & non Ferrous Metals		X				
9 Non Metallic Min Products		X				
10 Chemicals		X				
11 Metal Products		X				
12 Agr & Indus Machines		X				
13 Office machines		X				
14 Electrical Goods		X				
15 transport Equipment		X				
16 Food. Drink & Tobacco		X				
17 Tex.. Cloth & Footw.		X				
18 Paper & Printing Products		X				
19 Rubber & Plastic		X				
20 Other Manufactures		X				
21 Construction			X			
22 Distribution				X		
23 Lodging & Catering				X		
24 Inland Transports				X		
25 Sea & Air Transport				X		
26 Other Transports				X		
27 Communication				X		
28 Bank. Finance & Insurance					X	
29 Other Market Services					X	
30 Non Market Services						X

ABOUT NEUJOBS

"Creating and adapting jobs in Europe in the context of a socio-ecological transition"

NEUJOBS is a research project financed by the European Commission under the 7th Framework Programme. Its objective is to analyse likely future developments in the European labour market(s), in view of four major transitions that will impact employment - particularly certain sectors of the labour force and the economy - and European societies in general. What are these transitions? The first is the **socio-ecological transition:** a comprehensive change in the patterns of social organisation and culture, production and consumption that will drive humanity beyond the current industrial model towards a more sustainable future. The second is the **societal transition,** produced by a combination of population ageing, low fertility rates, changing family structures, urbanisation and growing female employment. The third transition concerns **new territorial dynamics** and the balance between agglomeration and dispersion forces. The fourth is **a skills (upgrading)** transition and and its likely consequences for employment and (in)equality.

Research Areas

NEUJOBS consists of 23 work packages organised in six groups:

- **Group 1** provides a conceptualisation of the **socio-ecological transition** that constitutes the basis for the other work-packages.
- **Group 2** considers in detail the main drivers for change and the resulting relevant policies. Regarding the drivers we analyse the discourse on **job quality**, **educationa**l needs, changes in the organisation of production and in the employment structure. Regarding relevant policies, research in this group assesses the impact of changes in **family composition**, the effect of **labour relations** and the issue of financing transition in an era of budget constraints. The regional dimension is taken into account, also in relation to **migration** flows.
- **Group 3** models economic and employment development on the basis of the inputs provided in the previous work packages.
- **Group 4** examines possible employment trends in key sectors of the economy in the light of the transition processes: energy, health care and goods/services for the **ageing** population, **care services**, housing and transport.
- **Group 5** focuses on impact groups, namely those vital for employment growth in the EU: **women**, the **elderly**, immigrants and **Roma**.
- **Group 6** is composed of transversal work packages: implications NEUJOBS findings for EU policy-making, dissemination, management and coordination.

For more information, visit: www.neujobs.eu

Project coordinator: Miroslav Beblavý (Miroslav.Beblavy@ext.ceps.eu)