CREATING AND ADAPTING JOBS IN EUROPE IN THE CONTEXT OF A SOCIO-ECOLOGICAL TRANSITION

EFFECTS OF THE MAIN GLOBAL SCENARIOS ON THE TRANSPORT SECTOR

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Abstract

The Neujobs project focuses on future possible developments of the European labour market given the socio-ecological transitions that European societies are facing. This paper focuses on the transport sector. The objective of this paper is to estimate the impact of expected trends in the transport sector on employment, given specific socio-ecological transitions. The characteristics of these transitions were developed in work package 1. The expected trends in the transport sector were treated in deliverable 15.1.
To assess the impact on employment we make use of the computable general equilibrium model EDIP. First, the socio-ecological transitions and trends in the transport sector are translated in EDIP by adjusting specific parameters. Next, the results of the model are discussed focussing on macro-economic parameters representing the state of the economy, social indicators, environmental indicators and adjustments in the labour market of each country. A sample of 8 representative countries was taken, from different regions in the European Union.
Our main conclusion is that the transport policies can lead to important gains in terms of job creation as well as reducing the impact of the economy on the ecosystem. The combined effect of the proposed transport policies leads to a reduction in greenhouse gasses and other pollutants from 1% to 9%, while leading to a net gain in jobs. In our sustainable world, less people are driving and buying cars, less people are employed in the manufacturing industry, but more people are employed performing transport and related services. This is caused by the combined effect of more expensive private transport and a shift in preferences towards public transportation.

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EFFECTS OF THE MAIN GLOBAL SCENARIOS ON THE TRANSPORT SECTOR

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1. Introduction

The Neujobs project focuses on future possible developments of the European labour market under the main assumption that European societies are now facing or preparing to face important socio-ecological transitions that will have a major impact on employment, in particular for some groups in the labour force or sectors of the economy.

This paper focuses on the transport sector. The objective is to estimate the impact of expected trends in the transport sector on employment, given specific socio-ecological transitions.

The characteristics of these transitions were developed in Work Package (WP) 1, resulting in a scenario matrix that combines possible background scenarios (friendly,though) and policy response scenarios (status quo, modernization, sustainability). The background scenarios describe two possible future megatrends, both for society and for natural conditions. They distinguish between a slow rate of change that is less challenging for Europe (friendly), and a more radical or rapid version (though). The three policy response scenarios differentiate in the rate of change that is induced by the response strategy, being either low (status quo), medium (modernization), or high (sustainability).

The expected trends in the transport sector were treated in deliverable 15.1. It was found that the current transport market is still predominantly car oriented, with low-energy efficiency and high carbon intensity. As a result, the socio-ecological transition is expected to have a profound impact on the transport sector as an employer, both in terms of the labour intensity of the sector as in the nature of commuting in Europe. Four big drivers for the coming decades were identified for changes in the transport sector: climate change and climate policy; fossil fuel scarcity; introduction of new propulsion technologies; changes in the logistic chain. The expected trends regarding these drivers were quantified and translated in the framework of the background scenarios of WP1, also using input from WP9 and WP10 of the NEUJOBS project. Policy domains that were found to be relevant for these drivers are tax policy, infrastructure policy, environmental policy and technological policy. In this paper, we derive a set of specific policy scenarios from these policy domains, for which we assess the impact on employment.

To assess this impact on employment we make use of a Computable General Equilibrium Model (CGE model) called EDIP. First, the socio-ecological transitions and trends in the transport sector are translated in EDIP by adjusting specific parameters. Next, the results of the model are discussed focussing on macro-economic parameters representing the state of the economy, social indicators, environmental indicators and adjustments in the labour market of each country. A sample of 8 representative countries was taken, from different regions in the European Union (EU): Austria, Belgium, Germany, Spain, Finland, Poland, Bulgaria and Greece.

Our main conclusion is that, while moving from status-quo to modernization and sustainability scenarios, important gains can be made in terms of job creation as well as reducing the impact of the economy on the ecosystem. The combined effect of the proposed policy leads to a reduction in greenhouse gasses and other pollutants from 1% to 9%, while at the same time leading to a net gain in jobs. In our sustainable world, less people are driving and buying cars, less people are employed in the manufacturing industry, but more people are employed performing transport and related services. This is caused by the combined effect of more expensive private transport and a shift in preferences towards public transportation.

The paper has been built up of complementary work, performed in other EU projects and calculates the joint and individual effects of a number of EU policies that are in the pipeline or could have far reaching impact on the EU economy. Given the far reaching nature of some of the policies, the simulations and work presented in this paper are very ambitious. They combine information of projects that has been compiled over several years.

In section 2 we first present the EDIP model, and discuss how it relates to other models used in the Neujobs project. The next section gives an overview of the entire scenario matrix that is evaluated using EDIP. We build our case presenting some key features of both the background scenario and the input to the policy scenarios used as input in EDIP. A more elaborate description of the EU scenarios is provided in D15.1. Section 4 discusses the results of these scenarios in terms of macro-economic parameters, social indicators, environmental indicators and adjustments in the labour market. Finally, we summarize and interpret the main results of this paper.

2. Short description of the EDIP model

We start with a short description of the EDIP model, providing a longer and more detailed description in the Appendix.

Distribution and Inequality Effects of Economic Policies (EDIP) is constructed using the Computable General Equilibrium (CGE) framework. CGE models are a class of economic models that use actual economic data to estimate how an economy might react to changes in policy, technology or other external factors. A model consists of (a) equations describing model variables and (b) a database (usually very detailed) consistent with the model equations. The EDIP model is based on the most recent publically available social, economic, environmental transport and energy data and the public version of the WIOD database. The EDIP database covers EU28 countries, Norway, Switzerland, and Turkey.

The EDIP model has a single mathematical formulation for all European countries. It is one model with 31 different versions, which are estimated using the country-specific dataset. The main element of the country-specific dataset of the EDIP model is the Social Accounting Matrix (SAM), which represents the annual monetary flows between different economic agents for the year 2007, which has been updated to 2010, using the available national account data. The SAM provides the model with a dataset in equilibrium, meaning that all accounting identities of the markets are correct. More specifically this signifies that everything which is produced is consumed. Government taxation is spent on public services or saved. Exports and imports are balanced by foreign savings. Capital and labour are employed and wages and returns flow back to the consumer's income. Savings equal investments and are enough to keep the economy on a fixed steady-state. This type of equilibrium is called a 'Walrasian' equilibrium.

The structure of the SAMs does not differ between the countries and corresponds to the overall structure of the EDIP model. Other country-specific data includes the socio-economic data related to different household types, labor market data, transport data, energy and emissions data. The EDIP model uses the latest available data from different statistical sources including EuroStat, national statistical offices, International Labor Organization, OECD, IEA etc.

The core equations of EDIP are based on nested CES functions. Nested CES functions are a way to represent the economic behaviour of households, firms and decision makers in a set of choices between substitutable goods. The main assumption is that households maximize utility and firms maximize profit. From these basic economic assumptions follow Marshallian demand equations, calibrated to replicate the base year of EDIP. The main solution to CES functions are well described in Rutherford (2002).

The labour market of EDIP is especially well worked out and applies a number of ILO based occupations and education levels that are representing the skill level and demand for each type of worker. The demand for each skill level is also a CES function, where the firm first chooses the relevant occupation and then the education level. The application of the wages – skill level set-up is comparable to Ottaviano & Peri (2006) and Ottaviano & Peri (2008), as well as Autor (2002). We assume that the labour supply adjusts following mechanisms similar to Blanchflower et al (2005), according to a wage curve using unemployment as its main determinant.

Comparing EDIP with other economic models used in Neujobs such as Nemesis from WP9 or the DSGE model from WP3, it can be concluded that the core economic model is very similar: they all use nested CES production functions with (skilled/unskilled) labour, capital, energy, and intermediate consumption as input; the external trade interaction is very similar; EDIP also allows for structural unemployment, similar as the other models. A difference is that in the other models efficiency gains are calculated endogenous, based on investments in R&D; in EDIP they are determined exogenously by looking at literature. More importantly, the transport sector and transport demand of households and firms is modelled in much more detail in EDIP. Since in this deliverable we are interested in the effect of transport related trends and policies, the choice for EDIP is straightforward.

A technical description of EDIP is available publically on http://www.tmleuven.be/project/refit/ in deliverable D4.2. An application and sensitivity analysis of EDIP is available in D6.3 of the REFIT FP6 project.

3. The scenario matrix

In this section we present the scenario matrix that will be evaluated using EDIP. This scenario matrix starts from the scenario matrix from WP1, which consists of two **background scenarios** and three **policy response scenarios**. Section 3.1 presents an overview of this original scenario matrix.

The expected background trends relevant for transport were developed in D15.1, and are discussed in section 3.2. They determine the context in the scenarios.

In section 3.3 we develop six additional policy response scenarios that focus on transport. These six additional transport policy scenarios are combined with the three main policy scenarios (status quo, modernization, sustainability) from WP1. In this set-up, the main policy scenarios determine the intensity of the measures for each transport policy. For example, we assume that fuel efficiency increases more in the modernization than in the status quo scenario, and more in the sustainability than in the modernization scenario. This leads to 6×3 different policy scenarios. To distinguish between the original three policy scenarios and the additional transport policy scenarios, we will refer to them as **main policy** scenarios and **transport policy** scenario respectively. The entire policy scenario matrix is presented in section 3.4.

These policy scenarios are combined with the two different background scenarios (friendly, though) from the Neujobs project. So in total there are 6×3×2 different scenarios.

3.1 Scenario Matrix of the NEUJOBS project

Table 1. Scenario matrix of the Neujobs project (Fischer-Kowalski et al. (2012))

	Friendly	**Tough**
Strategy 1: No policy changes	S1F 'Careless and globalized world'	S1T 'Challenged and ignorant world'
Strategy 2: Ecological modernization and eco-efficiency	S2F 'Ecologically aware and globalized world'	S2T 'Challenged, but ecologically aware world'
Strategy 3: Sustainability transformation	S3F 'Sustainable and globalized'	S3T 'Challenged and sustainable world'

NEUJOBS includes a comprehensive definition of scenarios based on Fischer-Kowalski, et al. (2012). Table 1 presents the scenario matrix from WP1 that combines possible background scenarios (friendly, though) and policy response scenarios (status quo, modernization, sustainability). The background scenarios describe two possible future megatrends, both for society and for natural conditions. They distinguish between a slow rate of change that is less challenging for Europe (friendly), and a more radical or rapid version (though). The three policy response scenarios differentiate in the rate of change that is induced by the response strategy, being either low (status quo), medium (modernization), or high (sustainability). For clarity and to be able to differentiate sufficiently between the different scenario combinations, we have given each scenario a particular name, to represent the situation it represents. We use the terms 'globalized' in the Friendly scenario to represent a world with low constraints in resources, free mobility of people and goods and moderate to low tensions on the political plain. The term 'challenged' is used for the tough scenarios as in this scenario resource scarcity, climate change, political and demographic pressures are leading to negative impacts on the globalized economy and world market.

These general background and policy scenarios are applied to transport in the next sections.

3.2 Specification of the background scenario in EDIP

The expected trends in transport have been translated in the framework of background scenarios in D15.1. To represent the background scenarios in a strategic policy assessment model such as EDIP, it is necessary to makes some abstraction of each scenario and define the impact of each background scenario on a number of parameters in the EDIP model. These parameters have been chosen explicitly for their importance in relation to the transport sector. The change in each parameter is consistent with D15.1 and with assumptions made in WP9 and WP10.

The baseline of EDIP in D15.2 is 2010, we perform a number of static runs representing the change in each parameter from 2010 to the reference year. The reference year for our simulation is 2030, similar as for the simulations in WP 9 using the Nemesis model. This choice is motivated by the availability of reliable data regarding future trends. For larger time horizons reliable quantitative estimates become rare, and the uncertainty on the model results will become too large.

Table 2. Percentage change in parameters related to the background scenarios - based on D15.1

Change 2010 - 2030	Friendly	Tough	Comments/ Explanation
Yearly GDP growth	EU 15: 1.5% EU 12: 3.0%	EU 15: 1.0% EU 12: 2.0%	GDP growth is one of the main drivers of transport demand
Price of coal	+10%	+15%	Impact on fuel mix
Price of gas	+20%	+50%	Impact on fuel mix
Price of petrol	+20%	+50%	Impact on fuel mix
Price of metal ores / metal products	+20%	+50%	Construction of transport equipment
Other raw materials	+20%	+50%	Fuel mix/resource scarcity
Price of agricultural products on world market	Stable	+10%	Impact on price of bio-fuels
Exchange rate	Stable (around 1.3 $/euro)	- 10% (around 1.2 $/ euro)	Raw oil, primary energy inputs and others are mainly import products
Efficiency of logistic sector / transport margins	Stable	-10%	We assume a reduction in efficiency of transport and an increase in the margin of transport in the consumer products due to congestion and climate change related extremes.
Population dynamics: Working population	WP 10	WP 10	The population dynamics in friendly and tough scenarios are based on WP10 by country results

The population dynamics have been extracted out of WP10 and presented in Table 3. The friendly scenario implies a large decrease in low skilled (around 30% in most countries) and large increase in high skilled labour force (+50%). The total workforce is stable or slightly decreasing. The tough scenario implies a lower decrease in low skilled (around 20%) and lower increase in high skilled labour force (+20-30%). The total workforce is moderately to strongly decreasing.

Table 3. Change in work force by skill level (% change 2010-2030)- own calculation based on WP10

	Friendly				**Tough**			
	Low	**Medium**	**High**	**Total**	**Low**	**Medium**	**High**	**Total**
AT	-31.9	-4.3	55.8	-0.86	-25.4	-4.8	6.3	-7.74
BE	-28.1	4.6	44.7	6.26	-25.5	8.1	22.2	1.50
BG	-38.3	-16.4	32.7	-12.33	-32.6	-31.0	-16.8	-28.65
CY	-34.9	7.5	62.1	12.44	-27.3	-3.2	30.4	0.41
CZ	-33.8	-11.4	65.2	-3.50	-20.8	-14.4	16.3	-10.86
DK	-30.3	-11.1	48.3	-0.12	-26.6	-4.8	24.0	-3.31
EE	-26.3	-11.1	28.4	-2.17	-15.1	-28.2	-16.5	-22.28
ES	-20.5	3.4	53.6	5.75	-24.6	0.4	13.7	-8.00
FI	-37.1	-13.5	30.8	-5.24	-30.6	-5.6	6.9	-7.59
FR	-31.7	-8.7	54.2	0.52	-28.9	-3.7	30.4	-2.74
GR	-30.2	-0.4	46.8	-1.98	-29.9	1.8	15.3	-7.57
IT	-17.1	5.6	80.1	4.77	-28.0	13.5	25.8	-4.09
LV	-46.5	-18.9	32.8	-12.65	-21.8	-34.4	-5.7	-25.47
LT	-42.6	-29.5	34.7	-14.36	-19.9	-36.3	9.3	-21.23
LU	-5.3	7.8	69.5	22.74	-2.8	8.8	44.6	16.32
MT	-27.2	-0.9	87.1	-7.96	-33.0	0.9	24.7	-19.63
NL	-31.2	-5.7	33.0	-2.76	-26.4	-3.6	10.4	-6.78
PL	-44.8	-23.0	61.8	-10.19	-36.7	-24.4	29.6	-15.99
PT	-18.6	-7.0	86.0	-1.91	-28.6	31.4	35.1	-8.28
RO	-38.1	-2.1	83.8	-2.80	-27.8	-22.1	16.1	-19.28
SK	-39.8	-11.7	62.7	-5.05	-28.3	-12.8	20.5	-10.30
SI	-24.9	-12.5	56.9	-1.01	-33.8	-10.2	21.9	-8.60
SE	-28.4	0.4	54.4	8.20	-17.5	-1.1	30.0	3.45
UK	-20.9	-1.6	39.0	5.47	-17.8	2.7	17.8	1.78

3.3 Specification of the transport policy scenarios in EDIP

The transport policy scenarios in EDIP are focussed on the transport sector and are focussed around 4 themes (see D15.1):

- Taxation policy: Internalization of external costs and switch from taxation of inputs (fuels) to use based taxation (congestion charging)
- Infrastructure: Increase in smart mobility, use of infrastructure based charges
- Environmental: Increase in energy and fuel efficiency
- Technology: Electrification

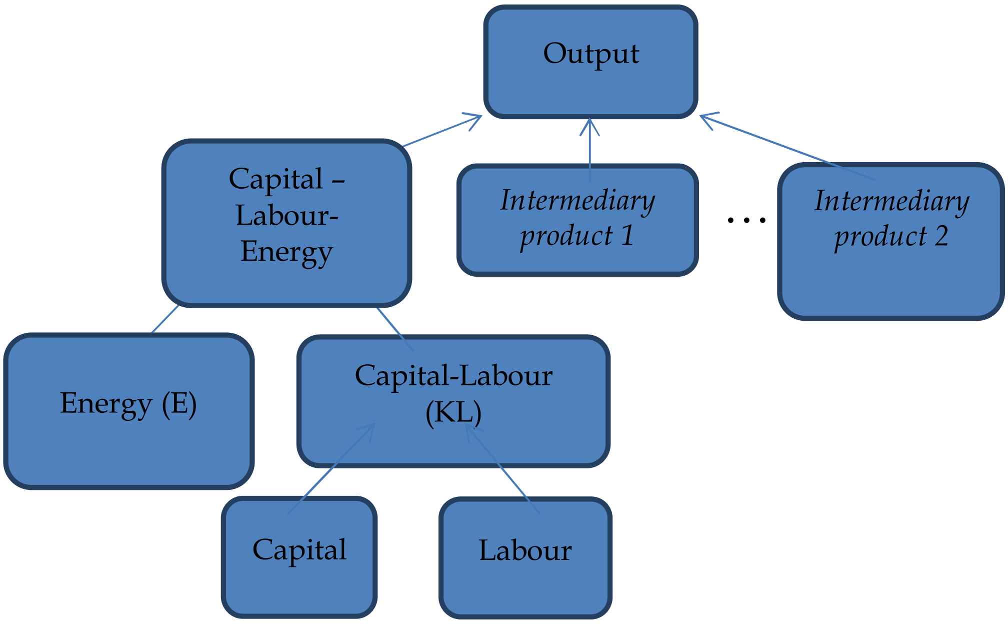
We reduce these themes to 6 applied transport policy scenarios, which we describe below

3.3.1 Increase in energy efficiency

We assume that in the modernization and sustainability scenarios the total energy use per unit of value added is decreasing at a stronger rate, due to technological policy and government stimulation. This is modelled in EDIP by recalibrating the production function of the energy intensive sectors to a lower preference for energy inputs and a higher preference for capital and labour. At the same time, we assume a gain in productivity for each sector, such that the same amount of goods can be produced with lower energy and material inputs.

In **Error! Reference source not found.** we show the representation of the production technology in the EDIP model. This is a schematic representation of how the production of a particular good in the model needs inputs of production factors (capital, labour and energy) and other products (intermediaries).

Figure 1. Representation of nested CES technology in EDIP



The use of energy, versus capital and labour is controlled by two exogenous parameters: the elasticity of substitution between the capital-labour bundle and the energy bundle and the preference of each sector for a particular bundle.

In its mathematical form, the demand for energy, capital and labour is represented by the formula below. This is a representation of a common CES function with parameters γ (determining the exogenous preference) and σ (the elasticity of substitution).The parameter a_T is introduced as a normalization parameter.

$$KLE^{new} = a_T{}^{new}\left(\gamma^{new}(KL^{new})^{\frac{\sigma-1}{\sigma}} + (1-\gamma^{new})(E^{new})^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}$$
$$= a_T{}^{new}\left(\gamma^{new}(KL^{new})^{\frac{\sigma-1}{\sigma}} + (1-\gamma^{new})\left(\frac{(1-x)}{100}E^{old}\right)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}$$
$$= KLE^{old}$$

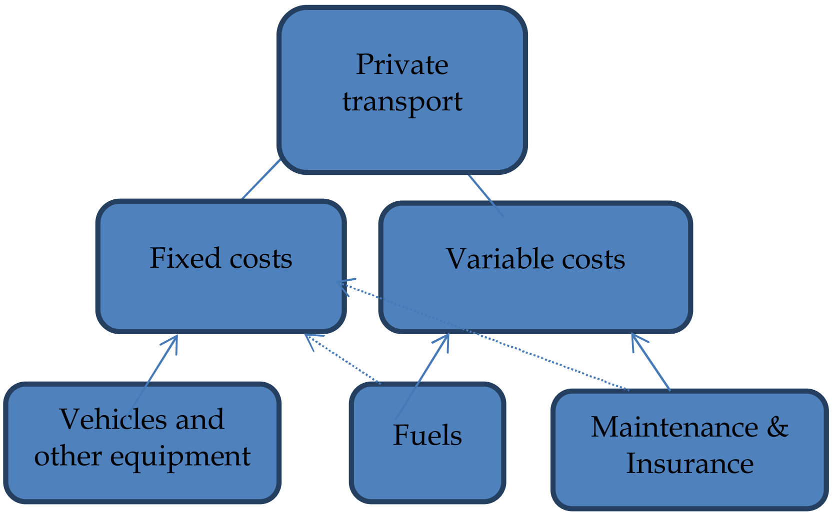
Taking KLE representative for the overall output, we can have that the ***same service*** of energy can be produced *with a lower actual* input of energy. For this to be introduced in the model, we have to recalibrate the γ parameter and renormalize the equation using a_T.

3.3.2 *Increase in fuel efficiency*

While the previous case dealt with efficiency gains with regard to energy use in the production process, this scenario looks at efficiency gains with regard to fuel use by motorized vehicles. In this transport policy scenario we take into account both the autonomous gains in productivity (calibrated from the TREMOVE model) and a larger gain in fuel efficiency due to active government intervention in the modernization and sustainability scenarios. The demand for inputs of car transport is schematically represented in **Error! Reference source not found.**. We assume that private transport consumption entails fixed costs (stock in vehicles) and variable costs (driving more), which requires fuels, maintenance and insurance. The lion's share of the fixed costs rests in buying the vehicle, but fuels and maintenance represent a smaller share of the fixed costs. This is to represent that the decision to buy a car is to some degree depending on fuel and insurance prices.

The increase in fuel efficiency is modelled by assuming that the same amount of 'car transport' can be produced with lower inputs of fuels. We calibrate this in such a way that the same budget is allocated to car transport, but with a lower share of fuel costs. This implies that the fuel efficiency comes at a cost: the increased fuel efficiency increases the purchasing value of a vehicle. The way this is modelled is similar to the case above, by introducing an updated production function with lower preferences for fuel and adding an additional normalization.

Figure 2. Production of private transport by consumers and firms



3.3.3 Electrification of transport

This scenario specifies an increase in the use of electrified transport for households from approximately zero in most European countries, up to 10% in the modernization and 20% in the sustainability scenario. The assumption of high electric vehicle penetration may seem overly optimistic. There are good reasons to believe that the prospects for electric vehicles in Europe are limited and that the benefit for society may actually be negative (Prudhomme, 2010; Crist, 2012). A study by CE Delft on electric vehicles (Gruning M et al, 2011) indicates that at least until 2015, penetration of electric vehicles will stay low in the EU. By 2030, the share of full electric vehicles is estimated between 1% and 7%.

Table 4. EU-27 passenger car fleet, share per vehicle type (from Gruning M et al, 2011)

Scenario 1	2010	2015	2020	2025	2030
Conventional	100%	100%	99%	94%	82%
PHEV	0%	0%	1%	4%	11%
EREV	0%	0%	0%	1%	4%
FEV	0%	0%	0%	1%	3%
Scenario 2	**2010**	**2015**	**2020**	**2025**	**2030**
Conventional	100%	100%	99%	97%	93%
PHEV	0%	0%	0%	2%	5%
EREV	0%	0%	0%	0%	1%
FEV	0%	0%	0%	0%	1%
Scenario 3	**2010**	**2015**	**2020**	**2025**	**2030**
Conventional	100%	100%	98%	88%	67%
PHEV	0%	0%	1%	7%	18%
EREV	0%	0%	0%	3%	8%
FEV	0%	0%	0%	2%	7%

We choose to apply a optimistic penetration of electric vehicles for 3 reasons. First the current level of achieved fuel economy is reaching its limits and is not costless to society either (Van Dender, 2011). Further improvements in fuel economy may need some degree of electrification or at least hybridization of transport. Secondly, there is a possibility that a technological breakthrough in capacity and recharging of electrical batteries can be achieved in the next two decades following current research on nanotechnology in battery recharging (Pikul James H., Ghang Zhang Hui, et al., 2013). Thirdly, we feel that to simulate the type of ambitious changes in policy that are described in the sustainability scenario of the NEUJOBS project we need a large technology shock in vehicle propulsion. Finally, while the estimated penetration rate of full electric vehicles by 2030 might be low, the estimated penetration rate of all electric vehicles combined is much higher. Gruning et al. estimate an electric vehicle penetration (combining full electric vehicles (FEV), plug-in hybrid electric vehicles (PHEV) and electric vehicles with range extender (EREV)) between 6% and 33%, with a more realistic penetration rate of 18% (see Table 4). EDIP only distinguishes between full electric vehicles and conventional vehicles. When distributing the PHEV and EREV between the full electric vehicles and conventional vehicles according to a reasonable allocation rule, the penetration rates of 10% and 20% become more realistic. For example, using a 80/20 and 20/80 allocation rule for PHEV and EREV to conventional and full electric vehicles respectively leads to a penetration rate of 8.4% in the realistic case (scenario 1 in Table 4), and 17% in the optimistic case (scenario 3 in Table 4). These values are closer to the penetration rates of 10% and 20% used in this policy scenario. We will come back on this discussion when discussing the results in section 4.

Making assumptions on the use of electrified transport is further burdened by the fact that there are only a few electric cars driving on the European roads in present days. We used the results of a market study performed by TML for the Belgian Federal government on electric mobility[1] to calibrate the household demand. In the table below, we give an overview of the optimal lifetime spending on electric cars versus conventional cars by spending category. We use this data to introduce a new technology for production of own road transport for households, based on electric propulsion. The technology is introduced as a 'backstop' technology. A combination of technological progress and subsidies is assumed to generate a larger demand for electrical mobility by 2030, following the respective main policy scenarios.

[1] Final report available at www.tmleuven.be/project/evfod/home.htm (in Dutch).

Table 5. Lifetime spending on electrical vehicles versus conventional (small and large) in euros of 2010 (based on market study for the Belgian Federal government on electric mobility[1])

	SMALL		LARGE	
	CONVENTIONAL	**ELECTRIC**	**CONVENTIONAL**	**ELECTRIC**
Purchase cost	12,500 €	17,500 €	30,000 €	37,500 €
Taxes	2,625 €	3,675 €	6,300 €	7,875 €
Fuel cost	5,845 €	1,661 €	8,804 €	4,194 €
Fuel tax	3,897 €	415 €	5,869 €	1,965 €
Insurance	1,250 €	1,750 €	3,000 €	3,750 €
Maintenance	1,625 €	1,365 €	3,900 €	4,875 €
Total	**27,742 €**	**26,366 €**	**57,873 €**	**60,159 €**

3.3.4 *Internalization of external costs of transport*

To model the internalization of external costs of transport, we introduce 3 representative scenarios of the IMPACT study (Van Essen et al, 2008). These scenarios were implemented using the TREMOVE model and the representative tax rates for each scenario are introduced to the transport demand of both firms and households.

We choose to implement the following impact scenarios:

- **Status quo**: IMPACT reference scenario 1 – Current policies in pipeline
- **Modernization**: IMPACT scenario 2 – Internalization through fuel taxes
- **Sustainability**: IMPACT scenario 5a – Pragmatic smart charging on all roads

Table 6. Overview of assumptions in IMPACT scenarios (Adapted from Van Essen, 2008)

Main policy scenario	**Infrastructure**	**Circulation tax**	**Fuel tax**	**Congestion**
Status quo	Current tolls and fixed infrastructure charges	Current purchase charge + circulation taxes (CO_2 based revenue)	EU minimum tax – current rates	None
Modernization	Same as status quo	Same as status quo	Including external costs of traffic (accidents, air, noise)	No evolution
Sustainability	Marginal infrastructure cost pricing on all roads + pricing for all externalities both for freight as passenger transport	Full circulation tax and pricing for all externalities.	Fuel tax is reduced and replaced by marginal cost pricing and congestion charges	Congestion charges differentiated by location, but not by time of day

3.3.5 *Reduced use of own transport*

In this transport policy scenario we assume a shift in preferences towards public transport. This transport policy scenario represents a number of changes in lifestyle and transport that induce a reduction of car use. Among others:

- Increased urbanization
- Car sharing
- 'Soft' measures to discourage car transport
- Improvement in quality and coordination of public transport services

We assume that after this shift people will be able to achieve the same utility with a lower share of own private road transport. In other words, people will not feel hindered more or less compared to now when reducing their private car use. This entails a recalibration of the model parameters similar as was done in section 3.3.1:

$$U^{new} = a_T{}^{new} \left(\gamma^{new} (PublicTr^{new})^{\frac{\sigma-1}{\sigma}} + (1-\gamma^{new}) \left(\frac{(1-x)}{100} PrivateTr^{old} \right)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} = U^{old}$$

This reduction x in the total use (and also total expenditure) of own produced household transport (passengers) necessary to get the same utility is 10% in the modernization and 20% in the sustainability scenario. Note that this is not equivalent to a total reduction of car use of respectively 10% and 20%: the shift in preferences leads to an altered consumption behaviour altogether that furthermore interacts with the rest of the economy. The total reduction of car use will be influenced by these effects.

3.3.6 Reduction in administrative inputs for freight transport

This transport policy implies a reduction of administrative barriers, following the e-Freight initiative of the EU. It follows from a stylized version of a more detailed EU-tender study on e-Freight performed with the EDIP model (http://www.tmleuven.be/project/efreight/home.htm). The report of the full study is not public yet, but will be posted on the link above, when ready.

The idea is to address inefficiencies in freight transport information exchange in the context of multimodal transport. Examples of this include duplication of information submission, lack of integration of information from tracking and tracing technologies, lack of multimodal information on transport services and of multimodal booking tools. These inefficiencies lead to increased administrative costs, a perceived complexity of multimodal transport and eventually to an under-exploitation of multimodal transport and a non-optimal use of the existing transport infrastructure. Removing these barriers could lead to a shift from pure road to multimodal freight transport, and will also make vehicle utilisation more efficient. The e-Freight Initiative will increase the efficiency of freight transport information exchanges for multimodal transport, by creating the appropriate framework to streamline the electronic flow of information associated with the physical flow of goods.

We implement the e-Freight scenario by assuming a reduction in the input of auxiliary transport services and infrastructure services for each transport mode. This increases the competitiveness of all transport sectors and reduces the cost of purchased transport services for (mainly) freight.

We distinguish the impact of e-Freight by main policy scenario in the following way

- Status quo: ineffective e-Freight scenario having a zero net-effect on administrative costs
- Modernization: 10% reduction in administrative cost of land (rail + road) transport, 5% in water transport and 1 % in air transport
- Sustainability: 30% reduction in administrative cost of land transport (rail + road), 15% in water transport and 3% in air transport

3.4 Overview of policy scenario matrix

In the rest of the paper we will use the following abbreviations for the main policy and transport policy scenarios.

Main policy scenarios

- SQ: Status-quo scenario
- MO: Modernization
- SU: Sustainability

Transport policy scenarios

- EE: Increase in energy efficiency (see section 3.3.1)
- FE: Increase in fuel efficiency (see section 3.3.2)
- ELEC: introduction of electric mobility (see section 3.3.3)
- INT: internalization of external costs (see section 3.3.4)
- USE: increased used of non-own produced transport (see section 3.3.5)
- EFR: e-Freight scenarios (see section 3.3.6)
- FULL: Full policy scenario: this refers to the combination of all above transport policy scenarios

Table 7 gives an overview of the parameters used for every combination of main policy and transport policy scenario.

Table 7. The policy scenario matrix in EDIP – D15.2

		SQ	**MO**	**SU**
	Change in behaviour / efficiency 2010-2030	Low change	Medium change	High change
EE	Energy efficiency increase / year	0.8%[2]	1.2%	1.5%
FE	Fuel efficiency of cars/year	1.0 %[3]	1.5 %	2.0 %
ELEC	Electrification of transport	None	Partial electrification up to 10% of fleet	Partial electrification up to 20% of fleet
INT	Internalization of external costs of transport	TREMOVE Basecase 2030	IMPACT project scenario 2 - 2030	IMPACT project scenario 5A -2030
USE	Reduced use of own car transport in favour of public transit and car sharing	None	Preference for private car transport – 10%	Preference for private car transport -20%
EFR	Reduction in administrative inputs to transport (e-Freight)	None	Based on e-Freight project (partial)	Based on e-Freight project (full)

[2] Average gain in energy efficiency from 1990-2005, IEA report (2008) on Worldwide Trends in Energy Use and Energy efficiency

[3] TREMOVE baseline + IEA report (2008)

4. Results from EDIP

4.1 Set-up of the EDIP model

In the applications below, we will use a static version of the EDIP model. This static version gives a one-shot new equilibrium of the EU (or national) economy when applying the sets of policies proposed. By comparing the base year equilibrium, with the new equilibrium, it is possible to derive what changes are implied when implementing the new policies. The most common way of representing these changes is in relative (percentage) changes from the initial equilibrium to the new equilibrium

We choose 2010 as a reference year for the EDIP model, the reference year for the simulation is 2030. Given that we cannot compare 2010 directly to 2030, we need to make an assumption of the economic evolution of our economy up till 2030. This is provided in the baseline scenario. We assume that all variables in the 'reference year' are inflated homogeneously with$(1+g)^{20}$, where g is the growth rate, except for a set of environmental variables that are related to the energy efficiency and emissions in EDIP.

We assume that the natural unemployment rate in 2030 is not significantly changed compared to the natural unemployment rate in 2010. This may be problematic for some countries. After the economic crisis a substantial increase in unemployment especially in Southern European countries (Spain, Italy, Greece) and to some degree in Eastern EU countries and other countries. Following the official EU information on Structural Unemployment in the EU (the NAWRU variable) available in Orlandi F. (2012) and the EC economic forecast from DG ECFIN (2012), we calibrated EDIP on relatively high structural unemployment rates for 2030.

We assume that the demographic shock, corresponding to 2030 will not change the natural unemployment rate. However, we take into account the changes in relative availability of skill levels and recalibrate demand for each skill on the availability of that particular skill. The overall unemployment in the country does not change, but is composed from different skill levels.

4.2 Introduction

4.2.1 Countries used in analysis

We run the EDIP model for the following countries, each representing a macro-region in Europe.

- **Western-European countries**: Belgium, Germany, Austria
- **Nordic countries**: Finland
- **Eastern-European countries**: Bulgaria, Poland
- **Southern-European countries**: Spain, Greece

4.2.2 Base year, reference year and status quo scenario

All results are generated from EDIP (base year 2010) with a reference year for the simulation equal to 2030. The indicator used is (if not indicated otherwise) the percentage deviation of the 2030 simulation from the reference scenario. This reference scenario is a 2010 scenario inflated with a constant growth rate (equal to the background scenario's GDP growth rate) and augmented with the status-quo policy scenario.

BASE	REFERENCE
EDIP 2010 input	EDIP 2010 with constant growth rate respective for friendly and tough background scenario + Status Quo scenario

Percentage deviations are calculated as

$$Result\ (\%Change) = \left[\frac{X_{POLICY}}{X_{REFERENCE}} - 1\right].100$$

Separating the assumption of the growth rate in GDP from the other changes in background parameters may look strange. The reason for this is that the assumption on the growth rate is largely exogenous for EDIP. In this way, we can better distinguish the impact of each aspect of the policy scenario.

4.2.3 *Interpreting the results*

Interpretation of an ambitious and complex scenario set, such as the one used in NEUJOBS is demanding and difficult. First of all, there is not guarantee that our assumptions will reflect 'the reality' in 2 decades. The world is too complex and the possibility of other shocks in the transport market and in other markets, having a serious influence on our results cannot be excluded.

So what can we say about policy impacts?

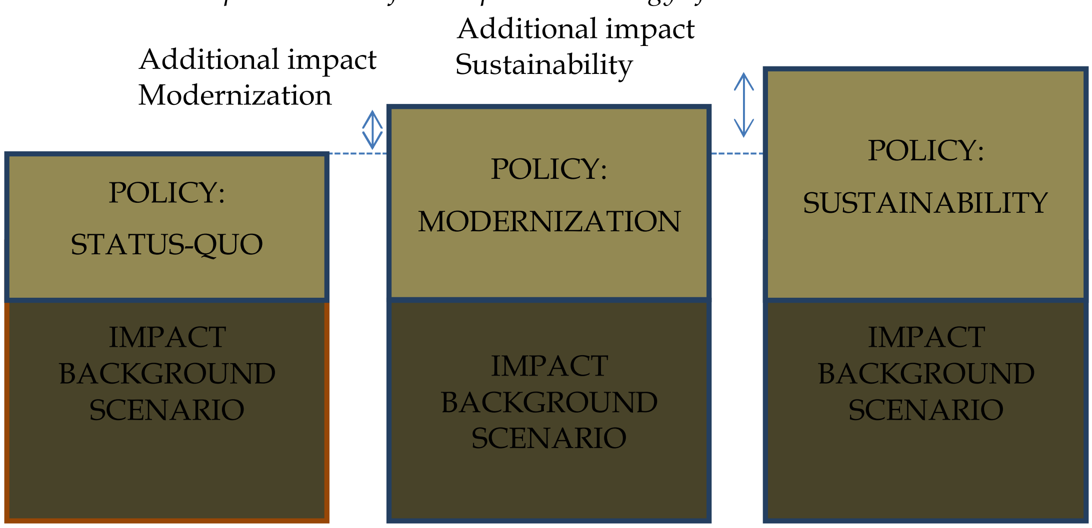
Our results will attempt to adequately decompose the **additional impact** of the group of transport policies we introduce in our modernization and sustainability scenario, compared to the status-quo. This can be represented by the following formula:

$$Total_{result} = Result_{SQ} + \boldsymbol{Result_{policy\ scenario}}$$

This signifies that we use the **status-quo scenario results as a reference and compare the additional effect of each other main policy scenario** (be it modernization or sustainability) with the status-quo scenario.

This is graphically represented in **Error! Reference source not found.**. What we will focus on in the sections below is the additional impact of the main policy scenarios, which are represented by the double-arrow in **Error! Reference source not found.**. This allows us to say what the relative impact of moving towards a more sustainable policy will be.

Figure 3. Schematic representation of decomposition strategy of the results



4.2.4 *Indicators chosen*

Since this report focuses on the transport sector, we will use the effect of the transport policies on the employment in this sector as an indicator. Each of the considered transport policies also has a social, economic and environmental impact on society. While this paper is primarily concerned with changes in employment, it is also important to consider these other indicators. First, it provides a better understanding in the indirect effects of a certain policy. Secondly, policy decisions generally face a trade-off between different goals. A scenario might lead to increased employment, but policy decision makers also need to know about any negative effects in this scenario (for example higher emissions, lower tax income) before being able to make an informed decision.

The chosen indicators have to reveal important changes in different areas. We choose the following indicators to assess and compare the different scenarios and policy options:

Table 8. Overview of indicators used in the analysis

Indicator	Description	Dimension
GDP per capita	Relative change in Gross Domestic Product per capita, calculated from the demographic change and the expected average growth rate from 2010-2030	Measures economic activity and production. Includes taxes on final consumption and taxes on income.
GHG per capita	Relative change in Greenhouse Gas Emissions per capita, calculated from the expected increase in fuel efficiency and the demographic change from 2010-2030	Measures the emissions of greenhouse gasses under the proposed changes in policy
Unemployment	Relative change (in percentage point) in unemployment rate from baseline unemployment rate	Measures the amount of unemployment.
Welfare	Relative change in compensating variation[4]	Measures total consumption of the population
Transport serv	Relative change in employment in public transport services	Measures employment in the public transport sector
Transport eq	Relative change in employment in the transport equipment and related manufacturing sectors	Measures employment in the automobile manufacturing sector.
Tax revenues	Relative change in total tax revenues	Measures the government's tax income

4.3 Impact assessment by indicator

This section presents an impact assessment for each of the selected countries and for each of the considered background scenarios (Friendly and Tough) and main policy options (Modernization and Sustainability). To retain some oversight, we order indicators in economic indicators, social indicators, environmental indicators and transport sector indicators. For each type of indicator (economic, social, environmental, transport), we start by giving an overview of the impact of the full scenarios (with simultaneous application of

[4] Compensating variation is a utility based welfare measure, which calculates the amount of money a (group of) individual(s) should receive to reach their initial utility after a change in prices. It is calculated directly from changes in the utility function, which are then multiplied with an appropriate price index.

all transport policy options from section 3.3) on each indicator. Next, we consider the impact of each transport policy option separately to determine the most promising policies. As discussed in section 4.2.3, in each case we report the difference of the modernization (ΔMO) and sustainability scenario (ΔSU) with the status-quo scenario (SQ).

How to interpret the results?

The effect of the transport policies in the next sections are all presented rounded to two-digit precision. However, this should not be interpreted as the accuracy of the model results. Given the assumptions and simplifications in CGE models in general, the (in)accuracy of their input data (e.g. social accounting matrix) and parameters (e.g. elasticities), and the uncertainty on the long-term prediction of scenario parameters (e.g. oil price, GDP growth), the model results rather indicate the order of magnitude and the direction of change following from a certain policy measure. The exact accuracy of the results is very difficult to derive. As discussed in Wing (2003), CGE models' usefulness in policy analysis owes to its ability to shed light on the economic mechanisms through which price and quantity adjustments are transmitted among markets.

By analysing these mechanisms in different countries (each with their own unique economic structure), different contexts (determined by the background scenarios) and for different intensities (in this case determined by the main policy scenario, see Table 7), it becomes possible to derive a general conclusion on the relevant economic mechanisms. Furthermore, comparing the results along the above dimensions (countries, context, intensity) provides a range for the effect of a policy measure that to some extent can serve as a proxy for the accuracy of the results.

4.3.1 Economic indicators

In the table below we focus on the impact of the total scenario on a number of key economic indicators. We take GDP per capita and the government tax revenues as the main economic indicators in this case.

Table 9. Percentage change of economic indicators with simultaneous application of transport policy options

		Friendly		Tough	
Country	**output_sim**	**ΔMO**	**ΔSU**	**ΔMO**	**ΔSU**
AT	GDP capita	0.65	1.17	0.63	1.16
BE	GDP capita	0.38	0.51	0.38	0.51
DE	GDP capita	0.14	0.47	0.14	0.47
ES	GDP capita	0.55	1.11	0.43	1.19
FI	GDP capita	0.05	0.04	0.05	0.08
GR	GDP capita	0.66	1.04	0.68	1.09
PL	GDP capita	0.19	0.26	0.18	0.26
BG	GDP capita	0.46	0.90	0.48	0.96
AT	Tax revenues	0.76	1.08	0.75	1.08
BE	Tax revenues	1.12	1.93	1.13	1.93
DE	Tax revenues	0.07	0.63	0.07	0.63
ES	Tax revenues	0.88	2.46	0.80	2.46
FI	Tax revenues	0.26	1.32	0.18	1.37
GR	Tax revenues	1.72	1.84	1.69	1.82
PL	Tax revenues	1.03	2.04	1.06	2.03
BG	Tax revenues	0.07	0.14	0.12	0.31

We see that moving from the Status Quo (SQ) to the Modernization (MO) and Sustainability (SU) scenario, we increase both tax revenues and GDP. The reason for this is that many of the proposed transport policies cause some additional cost to mobility, which increases government revenues and the 'tax part' of the GDP. Other transport policies increase efficiency, leading to increased production and increased GDP.

In most cases moving to the SU scenario offers better results than moving to the MO scenario. This is because the effects of the transport policy options in the SU scenario are larger in magnitude than those in the MO scenario (see Table 7).

Also interesting to see is that the **additional effect** of SU and MO scenario is very similar in magnitude in the Friendly and the Tough scenario for most countries. The difference in background scenario (fuel prices, population, …) does not significantly influence the effect of the policy options. Note that this does not mean that the net GDP per capita or the net amount of tax revenues is the same in the Friendly and Tough scenario: in the Friendly scenario these indicators are substantially higher than in the Tough scenario, and this remains the case after applying the discussed polices.

We now focus on each transport policy measure separately, to single out those policies that have the largest impact on GDP and tax revenues.

GDP

Table 10 and **Error! Reference source not found.** summarize the additional effect of the MO and SU scenario on GDP per capita for each of the individual transport policy options for each of the background scenarios.

Energy efficiency (EE) and e-Freight (EFR) policy are the largest stimulant for domestic production. The effect of both is positive for all countries, both in the friendly and tough scenario, because the savings due to the efficiency gains allow to increase production and consumption, leading to an increased GDP. For EE the GDP effect ranges between 0.06 and 0.6 for the (modernization, Friendly) scenario. These differences among countries follow from a difference in energy consumption: countries with a high energy consumption per GDP benefit more from increased energy efficiency. For EFR the GDP effect ranges between 0.06 and 0.6 for the (modernization, Friendly) scenario. Here the differences follow from a difference in administration cost in the total cost structure, and countries with a higher share of administration in the total cost benefit more from the e-Freight measures.

The taxation policy from the IMPACT study also leads to positive results for all countries. The reason that the IMPACT scenarios are leading to an increase in GDP is that they increase the user based taxes[5] and reducing former distortions in the taxation of freight. Difference in effect between countries is partly explained by the size of extra taxation required for internalization. However, also the structure of the economy plays an important role here. The extra taxation helps moving consumption away from oil, and spending it somewhere else (e.g. health and education). Whether and how beneficial this is for the economy depends on the structure of the economy in the country, i.e. the size of the sectors and the intermediate consumption patterns between them.

Electric mobility leads to a reduction in GDP for all countries. This happens by the following mechanism: switching to electric cars leads to a small decrease of the price of mobility for the consumer. However, since electricity is taxed less than fuels, the government loses income, and reduces its consumption. This decrease in government spending is harmful mostly for

[5] Tax income on the final use of transport services and own produced transport is an integral part of GDP

services sectors such as education and health, and the result is a reduction of GDP. Differences between countries are mainly resulting from a difference in taxation of electricity and fuel, and from a difference in the initial expenditures on fuel by consumers. Note also that the impact more or less doubles when input doubles: in the MO scenario the share of electric vehicles was 10%, while in the SU scenario it was 20%. Comparing the results from the MO and SU scenario, we see that the effect more or less doubles for most countries. Recalling the discussion in section 3.3.3 about the penetration rate of electric vehicles being too optimistic, it seems safe to presume that a lower estimate of the penetration rate will lead to a proportionally lower effect on GDP (and on all other indicators).

A similar effect happens in the fuel efficiency policy option, which also leads to a reduction in GDP in all countries. For the consumer there are no substantial savings, since the reduced fuel consumption is countered by increased spending on vehicle purchases. The government on the other hand loses tax income due to less fuel consumption, and will cut spending, affecting mainly the health and education sector.

Finally, the effect of reduced use of own transport on GDP per capita is more differentiated. We observe a decrease in countries with a higher GDP per capita (Austria, Belgium, Germany, Spain, Finland), and an increase in countries with a lower GDP per capita (Bulgaria, Greece, Poland). In the latter countries the initial private expenditure on public transport is also substantially higher than in the former countries. The shift from private to public transport decreases the tax revenues for the government, as public transport consumes less fuel than private transport. Similar as for the FE and USE policy, the government will cut spending in the health and education sector. This has a larger effect larger in countries with a high GDP per capita, where these sectors are relatively larger.

Table 10. Percentage change in GDP per capita in Friendly scenario

country	pol	EE	FE	ELEC	INT	USE	EFR	FULL
AT	Modernization	0.60	-0.02	-0.02	0.06	-0.03	0.06	0.65
AT	Sustainability	1.04	-0.03	-0.04	0.12	-0.06	0.14	1.17
BE	Modernization	0.06	-0.01	-0.02	0.24	-0.02	0.15	0.38
BE	Sustainability	0.11	-0.01	-0.04	0.12	-0.04	0.37	0.51
DE	Modernization	0.14	-0.04	-0.06	0.05	-0.04	0.09	0.14
DE	Sustainability	0.25	-0.09	-0.11	0.25	-0.08	0.21	0.47
ES	Modernization	0.32	-0.01	-0.06	0.13	-0.05	0.19	0.55
ES	Sustainability	0.55	-0.03	-0.07	0.34	-0.10	0.46	1.11
FI	Modernization	0.09	0.00	0.00	-0.02	-0.03	0.02	0.05
FI	Sustainability	0.15	-0.01	-0.01	-0.09	-0.07	0.04	0.04
GR	Modernization	0.09	-0.02	-0.01	0.41	0.05	0.14	0.67
GR	Sustainability	0.16	-0.05	-0.03	0.52	0.10	0.34	1.04
PL	Modernization	0.12	-0.05	-0.04	0.11	0.03	0.03	0.19
PL	Sustainability	0.21	-0.10	-0.09	0.09	0.05	0.07	0.26
BG	Modernization	0.36	-0.03	-0.03	0.00	0.01	0.16	0.46
BG	Sustainability	0.63	-0.05	-0.08	0.00	0.01	0.38	0.90

Table 11. Percentage change in GDP per capita in Tough scenario

country	pol	EE	FE	ELEC	INT	USE	EFR	FULL
AT	Modernization	0.58	-0.01	-0.02	0.06	-0.02	0.06	0.63
AT	Sustainability	1.04	-0.03	-0.04	0.12	-0.05	0.14	1.16
BE	Modernization	0.06	0.00	-0.01	0.23	-0.02	0.15	0.38
BE	Sustainability	0.11	-0.01	-0.04	0.12	-0.04	0.36	0.51
DE	Modernization	0.14	-0.04	-0.06	0.05	-0.04	0.09	0.14
DE	Sustainability	0.25	-0.09	-0.11	0.25	-0.08	0.21	0.47
ES	Modernization	0.32	-0.01	-0.04	0.12	-0.05	0.19	0.43
ES	Sustainability	0.55	-0.03	-0.06	0.33	-0.09	0.46	1.19
FI	Modernization	0.09	0.01	-0.06	-0.04	-0.06	0.00	-0.05
FI	Sustainability	0.18	-0.01	-0.02	-0.11	-0.08	0.03	0.08
GR	Modernization	0.10	-0.04	-0.19	0.38	0.06	0.13	0.68
GR	Sustainability	0.16	-0.05	-0.74	0.51	0.11	0.33	1.09
PL	Modernization	0.12	-0.05	-0.04	0.11	0.03	0.03	0.18
PL	Sustainability	0.21	-0.09	-0.08	0.09	0.06	0.07	0.26
BG	Modernization	0.36	-0.02	-0.02	0.00	0.02	0.18	0.48
BG	Sustainability	0.64	-0.02	-0.04	0.00	0.04	0.38	0.96

Regarding differences in effect between the Friendly and Tough scenario, comparison of Table 10 and **Error! Reference source not found.** indicates that these are minimal.

Tax revenues

The tax revenues are a second important economic indicator, since they determine the budget of a government. If tax revenues increase, there is more room for government spending which further stimulates the economy. The opposite is also true of course. The tax revenues also exhibit a hidden social dimension. In many countries a part of tax revenues is spent on public services such as education, health, transport, … While these services are enjoyed by the population, they are not directly purchased by them, and are therefore not included in the Welfare indicator in section 4.3.2. However, when tax revenues decrease and expenditure on these services is reduced, this will also have a negative impact on the population.

Table 12 and Table 13 summarize the additional effect of the MO and SU scenario on the tax revenues for each of the individual transport policy options for each of the background scenarios.

The largest increase in tax revenues is observed for the INT policy, which does not come as a surprise as in this scenario extra taxes on transport are levied. The differences between countries is determined by the size of extra taxation required for internalization as found by the IMPACT study.

Energy efficiency (EE) and e-Freight (EFR) lead to an increase of tax revenues. In both cases the increased tax revenues are a direct consequence of the increase of economic activity that is captured by the GDP. Because of this the effect on GDP and tax revenues are very much alike.

Switching to electric cars in the ELEC policy and increased fuel efficiency in the FE policy leads to a decrease of tax revenues for all countries due to the loss of taxes on fuel consumption.

Also in the USE policy reduced fuel consumption due to the shift from private to public transport is at the base of the decrease in tax revenues.

Table 12. Percentage change in tax revenues in Friendly scenario

Country	pol	EE	FE	ELEC	INT	USE	EFR	FULL
AT	Modernization	0.46	-0.05	-0.06	0.42	-0.07	0.06	0.76
AT	Sustainability	0.78	-0.09	-0.11	0.46	-0.14	0.14	1.08
BE	Modernization	0.04	-0.03	-0.05	1.11	-0.06	0.14	1.12
BE	Sustainability	0.07	-0.05	-0.09	1.74	-0.12	0.35	1.93
DE	Modernization	0.07	-0.12	-0.15	0.29	-0.08	0.06	0.07
DE	Sustainability	0.12	-0.24	-0.31	1.01	-0.16	0.15	0.63
ES	Modernization	0.25	-0.05	-0.01	0.75	-0.11	0.18	0.88
ES	Sustainability	0.43	-0.11	-0.15	2.07	-0.23	0.43	2.46
FI	Modernization	0.08	-0.01	0.00	0.29	-0.10	0.02	0.26
FI	Sustainability	0.14	-0.03	-0.01	1.34	-0.20	0.04	1.32
GR	Modernization	0.05	-0.08	-0.05	1.79	-0.01	0.02	1.72
GR	Sustainability	0.08	-0.17	-0.11	2.01	-0.03	0.05	1.84
PL	Modernization	0.05	-0.14	-0.13	1.25	0.00	0.02	1.03
PL	Sustainability	0.09	-0.27	-0.26	2.36	0.00	0.04	2.04
BG	Modernization	0.21	-0.10	-0.10	0.00	-0.02	0.12	0.07
BG	Sustainability	0.38	-0.19	-0.24	0.00	-0.08	0.27	0.14

Table 13. Percentage change in tax revenues in Tough scenario

Country	pol	EE	FE	ELEC	INT	USE	EFR	FULL
AT	Modernization	0.45	-0.05	-0.06	0.43	-0.06	0.05	0.75
AT	Sustainability	0.79	-0.09	-0.12	0.48	-0.13	0.13	1.08
BE	Modernization	0.04	-0.03	-0.03	1.13	-0.06	0.14	1.13
BE	Sustainability	0.07	-0.05	-0.10	1.74	-0.12	0.35	1.93
DE	Modernization	0.07	-0.12	-0.17	0.28	-0.09	0.05	0.07
DE	Sustainability	0.12	-0.25	-0.32	0.99	-0.17	0.14	0.63
ES	Modernization	0.25	-0.05	-0.14	0.77	-0.11	0.18	0.80
ES	Sustainability	0.44	-0.10	-0.16	2.06	-0.22	0.43	2.46
FI	Modernization	0.08	0.00	-0.07	0.27	-0.14	0.00	0.18
FI	Sustainability	0.17	-0.03	-0.04	1.33	-0.21	0.02	1.37
GR	Modernization	0.05	-0.14	-0.05	1.82	-0.01	0.02	1.69
GR	Sustainability	0.08	-0.17	-0.11	1.99	-0.02	0.05	1.82
PL	Modernization	0.07	-0.14	-0.13	1.27	-0.02	0.02	1.06
PL	Sustainability	0.09	-0.26	-0.28	2.39	0.01	0.04	2.03
BG	Modernization	0.28	-0.05	-0.12	0.00	-0.04	0.17	0.12
BG	Sustainability	0.38	-0.08	-0.22	0.00	-0.02	0.25	0.31

The differences in effect between the Friendly and Tough scenario are again minimal.

4.3.2 *Social indicators*

The table below shows the impact of the total scenario on two social indicators, namely the unemployment and welfare. The impact on unemployment is expressed in percentage point. So a decrease of unemployment from 7.5% to 7% would be indicated as -0.5%. Welfare expresses the total consumption of self-purchased goods by the population.

Table 14. Percentage point[1]/percentage[2] change of social indicators with simultaneous application of transport policy options

		Friendly		Tough	
Country	**output_sim**	**ΔMO**	**ΔSU**	**ΔMO**	**ΔSU**
AT	Unemployment[1]	-0.25	-0.41	-0.23	-0.42
BE	Unemployment[1]	-0.20	-0.22	-0.18	-0.21
DE	Unemployment[1]	-0.16	-0.30	-0.15	-0.30
ES	Unemployment[1]	-0.30	-0.53	-0.24	-0.57
FI	Unemployment[1]	-0.06	-0.04	-0.02	-0.03
GR	Unemployment[1]	-0.41	-0.57	-0.39	-0.54
PL	Unemployment[1]	-0.15	-0.23	-0.14	-0.21
BG	Unemployment[1]	-0.18	-0.34	-0.25	-0.43
AT	Welfare[2]	0.50	1.04	0.47	1.03
BE	Welfare[2]	-0.37	-0.43	-0.39	-0.45
DE	Welfare[2]	0.17	0.15	0.17	0.16
ES	Welfare[2]	0.29	0.25	0.17	0.28
FI	Welfare[2]	0.02	-0.42	0.01	-0.41
GR	Welfare[2]	0.03	0.5	0.03	0.5
PL	Welfare[2]	-0.11	-0.19	-0.13	-0.23
BG	Welfare[2]	0.64	1.26	0.69	1.29

We see that unemployment decreases for all countries when moving from the Status Quo (SQ) to the Modernization (MO) and Sustainability (SU) scenario. The reason for this is that many of the proposed transport policies increase government spending, giving a boost to the service sectors which are more labour-intensive than industrial sectors. For welfare the effects are more ambiguous.

In most cases moving to the SU scenario offers better results than moving to the MO scenario. This is because the effects of the transport policy options in the SU scenario are larger in magnitude than those in the MO scenario (see Table 7). The additional effect of SU and MO scenario is again very similar in magnitude in the Friendly and the Tough scenario for most countries.

We now focus on each transport policy measure separately, to single out those policies that have the largest impact on unemployment and welfare.

Unemployment

Table 15 and Table 16 summarize the additional effect of the MO and SU scenario on unemployment for each of the individual transport policy options for each of the background scenarios.

Fuel efficiency and electrification of transport both lead to an increase in unemployment, all other transport policy options decrease unemployment. Both policies lead to a shift in employment. In both cases, employment increases in the automobile sector due to the increased spending on vehicles, and decreases in the service sectors due to cuts in government spending. However, the negative effect in the service sectors is dominant because these sector are more labour-intensive. The net result is an increase in unemployment.

Energy efficiency and e-Freight lead to a decrease of unemployment due to the increased economic activity caused by both policies. In the case of EE policy, there is an increase of employment mainly in the service sectors. The largest effect can be observed in countries where energy consumption (and therefore also savings) and/or unemployment is high. For the EFR policy there is an increase of employment mainly in the transport sector.

Also the taxation in the INT policy leads to a decrease of unemployment for most countries. There is a shift in employment opposite to the one on the FE and ELEC policy, from automobile and transport sector to service sectors such as health and education.

Finally, the shift from private to public transport in the USE policy is also beneficial for employment for most countries. This decrease in unemployment follows directly from the fact that private transport requires no employed labour, and public transport does. However, this also has an impact on other sectors through the labour market, increasing the price of labour. Furthermore, the shift from private to public transport also leads to reduced fuel consumption, and therefore reduced tax revenues. This has a negative impact on government spending on health and education, reducing employment in these sectors. For most countries the net effect is a decrease in unemployment; only for Spain the result is an increase of unemployment.

Table 15. Percentage point change in unemployment in Friendly scenario

country	pol	EE	FE	ELEC	INT	USE	EFR	FULL
AT	Modernization	-0.20	0.00	0.00	-0.02	-0.01	-0.01	-0.25
AT	Sustainability	-0.34	0.00	0.01	-0.03	-0.01	-0.03	-0.41
BE	Modernization	-0.02	-0.02	0.01	-0.08	-0.04	-0.06	-0.20
BE	Sustainability	-0.03	-0.03	0.01	0.04	-0.08	-0.14	-0.22
DE	Modernization	-0.05	0.00	0.01	-0.03	-0.09	-0.01	-0.16
DE	Sustainability	-0.09	0.01	0.02	-0.05	-0.17	-0.03	-0.30
ES	Modernization	-0.19	0.00	0.06	-0.05	0.02	-0.10	-0.30
ES	Sustainability	-0.32	0.00	0.04	-0.11	0.05	-0.23	-0.53
FI	Modernization	-0.04	0.00	0.00	0.01	-0.03	-0.01	-0.06
FI	Sustainability	-0.07	0.00	0.00	0.11	-0.05	-0.02	-0.04
GR	Modernization	-0.03	0.03	0.01	-0.25	-0.21	0.05	-0.41
GR	Sustainability	-0.05	0.07	0.03	-0.32	-0.41	0.12	-0.57
PL	Modernization	-0.05	0.05	0.03	-0.10	-0.07	-0.01	-0.15
PL	Sustainability	-0.08	0.09	0.06	-0.12	-0.14	-0.02	-0.23
BG	Modernization	-0.15	0.01	0.01	0.00	-0.04	-0.03	-0.18
BG	Sustainability	-0.27	0.02	0.05	0.00	-0.07	-0.07	-0.34

Table 16. Percentage point change in unemployment in Tough scenario

country	pol	EE	FE	ELEC	INT	USE	EFR	FULL
AT	Modernization	-0.20	0.00	0.01	-0.02	-0.01	-0.01	-0.23
AT	Sustainability	-0.34	0.00	0.01	-0.02	-0.02	-0.03	-0.42
BE	Modernization	-0.02	-0.02	0.00	-0.07	-0.04	-0.06	-0.18
BE	Sustainability	-0.03	-0.03	0.01	0.06	-0.08	-0.14	-0.21
DE	Modernization	-0.05	0.00	0.02	-0.02	-0.08	-0.01	-0.15
DE	Sustainability	-0.09	0.01	0.02	-0.05	-0.16	-0.02	-0.30
ES	Modernization	-0.19	0.00	0.01	-0.04	0.02	-0.10	-0.24
ES	Sustainability	-0.33	0.00	0.04	-0.08	0.04	-0.24	-0.57
FI	Modernization	-0.04	0.00	0.01	0.04	0.00	0.00	-0.02
FI	Sustainability	-0.08	0.00	0.00	0.15	-0.05	-0.02	-0.03
GR	Modernization	-0.05	0.07	0.01	-0.26	-0.22	0.04	-0.39
GR	Sustainability	-0.04	0.07	0.03	-0.31	-0.40	0.13	-0.54
PL	Modernization	-0.04	0.05	0.03	-0.10	-0.08	-0.01	-0.14
PL	Sustainability	-0.07	0.10	0.05	-0.11	-0.15	-0.02	-0.21
BG	Modernization	-0.16	0.02	0.01	0.00	-0.05	-0.05	-0.25
BG	Sustainability	-0.27	-0.01	-0.01	0.00	-0.05	-0.06	-0.43

The differences in effect between the Friendly and Tough scenario are larger than in the case of GDP or tax revenues. However, there is no clear trend, not for countries nor for transport policy options: for some countries/ transport policy options the effect is larger in Friendly case than in the Tough case, for others the opposite is true. While the differences are larger than in the case of GDP or tax revenues, they are still limited in most cases.

Welfare

Table 17 and Table 18 summarize the additional effect of the MO and SU scenario on welfare for each of the individual transport policy options for each of the background scenarios.

For energy efficiency and e-Freight the effect on welfare is positive. The increased efficiency in both cases increase economic activity, and both the population, the firms and the government benefit from this in the form of increased income. For the population this increased income leads to increased consumption. The increase in welfare is closely related to the increase in GDP, and differences among countries can be explained similarly as in the case of GDP, namely due to differences in energy consumption and administrative cost reduction.

The shift from public to private transport in the USE policy also increases welfare, because due to the increased fuel prices public transport becomes relatively cheaper than private transport: in private transport a larger share of the total cost goes to fuel, so an increase in fuel prices is felt more heavily in private transport. By switching to public transport households retain more budget for consumption, leading to an increase in welfare.

The taxation in the INT policy has the opposite effect: household budget decreases due to the extra taxation, and as a result consumption drops.

In the fuel efficiency and electrification policy there are two main effects. First of all, there is a positive effect because of the decreased fuel consumption. While the decreased fuel consumption is normally balanced by increased vehicle purchase costs, the increase of the fuel price tips the balance in favour of the decreased fuel consumption. So the direct effect is a net benefit for the consumer. However, as was discussed in section 4.3.1, the reduction in fuel consumption also decreases tax income for the government, which has a negative impact on the economy. This indirect effect will reduce the budget of the consumer. The net effect for the consumer depends on the size of both effects. In Belgium, Greece and Poland the net effect is negative, and welfare decreases. In Austria, Germany and Bulgaria the net effect is positive.

Table 17. Percentage change in welfare in Friendly scenario

country	pol	EE	FE	ELEC	INT	USE	EFR	FULL
AT	Modernization	0.58	0.02	0.02	-0.23	0.07	0.05	0.50
AT	Sustainability	0.93	0.04	0.03	-0.24	0.13	0.13	1.04
BE	Modernization	0.05	-0.02	-0.01	-0.66	0.13	0.10	-0.37
BE	Sustainability	0.09	-0.04	-0.03	-0.97	0.27	0.24	-0.43
DE	Modernization	0.13	0.01	0.01	-0.17	0.11	0.08	0.17
DE	Sustainability	0.23	0.02	0.01	-0.51	0.23	0.19	0.15
ES	Modernization	0.31	0.02	0.08	-0.29	0.06	0.19	0.29
ES	Sustainability	0.54	0.03	-0.01	-0.85	0.12	0.45	0.25
FI	Modernization	0.08	0.00	-0.01	-0.18	0.09	0.01	0.02
FI	Sustainability	0.14	0.01	-0.01	-0.80	0.19	0.03	-0.42
GR	Modernization	0.09	0.00	-0.03	-0.38	0.20	0.15	0.03
GR	Sustainability	0.15	-0.01	-0.07	-0.34	0.42	0.35	0.50
PL	Modernization	0.13	-0.01	-0.01	-0.40	0.13	0.03	-0.11
PL	Sustainability	0.23	-0.01	-0.02	-0.73	0.27	0.07	-0.19
BG	Modernization	0.36	0.04	0.04	0.00	0.08	0.15	0.64
BG	Sustainability	0.62	0.08	0.04	0.00	0.16	0.35	1.26

Table 18. Percentage change in welfare in Tough scenario

country	pol	EE	FE	ELEC	INT	USE	EFR	FULL
AT	Modernization	0.54	0.02	0.01	-0.24	0.06	0.05	0.47
AT	Sustainability	0.97	0.04	0.03	-0.24	0.13	0.13	1.03
BE	Modernization	0.05	-0.02	-0.01	-0.67	0.13	0.10	-0.39
BE	Sustainability	0.10	-0.05	-0.03	-0.98	0.26	0.24	-0.45
DE	Modernization	0.14	0.01	-0.02	-0.19	0.10	0.07	0.17
DE	Sustainability	0.24	0.01	0.00	-0.53	0.21	0.18	0.16
ES	Modernization	0.32	0.01	0.01	-0.29	0.06	0.20	0.17
ES	Sustainability	0.54	0.03	-0.01	-0.85	0.14	0.46	0.28
FI	Modernization	0.09	0.03	-0.05	-0.21	0.08	-0.01	0.01
FI	Sustainability	0.18	0.00	0.01	-0.80	0.20	0.03	-0.41
GR	Modernization	0.10	-0.01	-0.03	-0.36	0.22	0.09	0.03
GR	Sustainability	0.15	-0.01	-0.07	-0.34	0.42	0.35	0.50
PL	Modernization	0.13	-0.01	-0.01	-0.41	0.13	0.03	-0.13
PL	Sustainability	0.22	-0.01	-0.03	-0.74	0.26	0.07	-0.23
BG	Modernization	0.38	0.03	-0.03	0.00	0.08	0.15	0.69
BG	Sustainability	0.68	0.07	0.08	0.00	0.15	0.35	1.29

4.3.3 Environmental indicators

In this paragraph we focus on the impact of the total scenario on the emission of greenhouse gases (GHG) per capita. Table 19 summarizes the results.

We see that introducing the transport policies according to the MO or SU scenario leads to a decrease of GHG per capita for all countries compared to the SQ scenario. This does not come as a surprise since almost all transport policies are directly aimed at decreasing energy and fuel consumption.

Table 19. Percentage change of environmental indicators with simultaneous application of transport policy options

		Friendly		Tough	
Country	**output_sim**	**ΔMO**	**ΔSU**	**ΔMO**	**ΔSU**
AT	GHG per capita	-1.17	-0.79	-1.30	-0.96
BE	GHG per capita	-4.05	-5.06	-4.22	-5.29
DE	GHG per capita	-4.66	-7.76	-5.04	-8.56
ES	GHG per capita	-3.63	-5.30	-3.66	-6.45
FI	GHG per capita	-2.90	-5.04	-2.77	-4.63
GR	GHG per capita	-5.82	-6.25	-6.27	-7.67
PL	GHG per capita	-3.33	-5.60	-3.72	-6.13
BG	GHG per capita	-2.03	-3.56	-2.21	-3.51

Similar as for the other indicators moving to the SU scenario offers better results than moving to the MO scenario for most countries. This is because the effects of the transport policy options in the SU scenario are larger in magnitude than those in the MO scenario (see Table 7). Also similar as before is that the additional effect of SU and MO scenario is very similar in magnitude in the Friendly and the Tough scenario for most countries. For most countries the effect is larger in the Tough scenario.

We now focus on each transport policy measure separately, to single out those policies that have the largest impact on GHG per capita. The results are summarized in Table 20 and

Table 21.

The EFR policy is the only policy in which GHG emissions increase for all countries. This policy makes freight transport more efficient in terms of administration and therefore less expensive. Because of this demand for transport will increase. This can both be in the form of more trips, or because of longer distances. The increase in freight transport leads to an increase of fuel consumption and GHG emissions.

The two polices that help reduce GHG emissions most are the EE and FE policy. Both policies address the consumption of energy directly by making it more efficient, thereby reducing consumption and thus reducing GHG emissions. In all cases this gain is offset by an increased demand. This is known as a rebound effect, leading to a lower reduction in GHG than would be expected based on the initial GHG emissions and the efficiency gain. In the case of Austria an increase in energy efficiency even leads to an increase of GHG emissions. What happens here is the so-called Jevons paradox (also known as “back-fire”): the increased efficiency accelerates economic growth, thereby increasing the demand for energy so much that the original energy savings are undone. This explanation is in accordance with the results from section 4.3.1, where we could observe that the GDP increase in Austria because of the energy efficiency was much larger than in other countries.

The ELEC policy shifts consumption from oil to electricity, which normally (depending on how the electricity was generated) causes lower CO2 emissions. Furthermore, the policy causes a small shrink of the economy, reducing the GHG per capita even further.

The extra taxation of private and freight transport in the INT policy reduces transport demand, leading to a decrease of fuel consumption and GHG emissions. Note that for many countries the effect in SU case is smaller than in the MO case. This is because I the SU case there is a partial shift from fuel taxes to car purchase taxes.

Similarly, the shift from private to public transport in the USE policy decreases fuel consumption, since public transport is less fuel intensive than private. The result is also a decrease of GHG emissions.

Table 20. Percentage change in GHG per capita in Friendly scenario

country	pol	EE	FE	ELEC	INT	USE	EFR	FULL
AT	Modernization	0.53	-0.46	-0.44	-0.98	-0.19	0.08	-1.17
AT	Sustainability	0.90	-0.91	-0.87	-0.40	-0.40	0.20	-0.79
BE	Modernization	-0.83	-0.70	-0.52	-2.03	-0.31	0.23	-4.05
BE	Sustainability	-1.45	-1.40	-1.16	-1.29	-0.63	0.55	-5.06
DE	Modernization	-1.45	-1.00	-0.80	-0.74	-0.84	0.07	-4.66
DE	Sustainability	-2.57	-1.98	-1.54	-0.51	-1.68	0.17	-7.76
ES	Modernization	-1.44	-0.58	-0.47	-1.12	-0.19	0.19	-3.63
ES	Sustainability	-2.52	-1.15	-0.84	-0.93	-0.39	0.46	-5.30
FI	Modernization	-1.92	-0.31	-0.11	-0.58	-0.05	0.01	-2.90
FI	Sustainability	-3.35	-0.61	-0.22	-0.90	-0.11	0.03	-5.04
GR	Modernization	-1.27	-1.07	-0.72	-2.32	-0.26	0.43	-5.82
GR	Sustainability	-2.26	-2.18	-1.42	-0.98	-0.53	1.05	-6.25
PL	Modernization	-2.32	-0.31	-0.18	-0.54	-0.04	0.02	-3.33
PL	Sustainability	-4.05	-0.61	-0.38	-0.70	-0.08	0.05	-5.60
BG	Modernization	-1.14	-0.56	-0.24	0.00	-0.29	0.14	-2.03

BG	Sustainability	-2.00	-1.09	-0.52	0.00	-0.53	0.34	-3.56

Table 21. Percentage change in GHG per capita in Tough scenario

country	pol	EE	FE	ELEC	INT	USE	EFR	FULL
AT	Modernization	0.73	-0.49	-0.49	-1.09	-0.21	0.09	-1.30
AT	Sustainability	1.39	-0.98	-0.93	-0.45	-0.44	0.22	-0.96
BE	Modernization	-0.88	-0.73	-0.60	-2.12	-0.31	0.23	-4.22
BE	Sustainability	-1.54	-1.44	-1.21	-1.36	-0.63	0.56	-5.29
DE	Modernization	-1.65	-1.13	-0.84	-0.84	-0.95	0.05	-5.04
DE	Sustainability	-2.87	-2.25	-1.75	-0.61	-1.87	0.11	-8.56
ES	Modernization	-1.70	-0.67	-0.67	-1.33	-0.22	0.19	-3.66
ES	Sustainability	-2.91	-1.30	-1.19	-1.13	-0.49	0.50	-6.45
FI	Modernization	-2.01	-0.29	-0.10	-0.72	-0.06	0.01	-2.77
FI	Sustainability	-3.40	-0.63	-0.20	-0.96	-0.11	0.03	-4.63
GR	Modernization	-1.38	-1.21	-0.89	-2.62	-0.32	0.51	-6.27
GR	Sustainability	-2.42	-2.43	-1.62	-0.98	-0.59	1.13	-7.67
PL	Modernization	-2.54	-0.32	-0.21	-0.62	-0.05	0.03	-3.72
PL	Sustainability	-4.42	-0.64	-0.45	-0.77	-0.09	0.06	-6.13
BG	Modernization	-1.38	-0.67	-0.30	0.00	-0.35	0.17	-2.21
BG	Sustainability	-2.36	-0.58	-0.39	0.00	-0.70	0.41	-3.51

The differences between the Friendly and Tough scenario are again not spectacular, but this time there is a clear trend observable. In the Tough scenario for most countries and policies the effect on GHG emissions per capita is larger than in the Friendly scenario.

4.3.4 *Sector employment indicators*

Finally, we look at the impact of the total scenario on employment in two transport sectors, namely the transport equipment sector that sells vehicles, and the transport sector that provides mobility services.

Table 22. Percentage change of sector employment indicators with simultaneous application of transport policy options

		Friendly		Tough	
Country	**output_sim**	**ΔMO**	**ΔSU**	**ΔMO**	**ΔSU**
AT	Transport eq	-0.49	-1.82	-0.51	-1.83
BE	Transport eq	-1.03	-7.35	-1.17	-7.07
DE	Transport eq	-1.26	-5.18	-1.25	-5.14
ES	Transport eq	-1.55	-12.38	-0.71	-12.29
FI	Transport eq	-0.77	-2.32	-0.71	-2.15
GR	Transport eq	-2.03	-3.47	-2.03	-3.43
PL	Transport eq	-0.21	-2.08	-0.11	-1.96
BG	Transport eq	-0.44	-0.86	-0.58	-0.99
AT	Transport serv	3.84	11.73	3.78	11.70
BE	Transport serv	6.60	15.73	6.39	15.45
DE	Transport serv	16.76	33.56	16.67	33.53
ES	Transport serv	9.49	21.08	9.38	20.95
FI	Transport serv	5.28	7.98	5.31	7.19
GR	Transport serv	12.63	28.89	12.36	28.26
PL	Transport serv	3.06	7.91	2.96	7.86
BG	Transport serv	6.41	13.43	6.28	13.17

Employment in the transport equipment sector decreases, while it increases in the transport service sector when implementing the transport polices according to the MO or SU scenario. The decrease in the transport equipment sector is a result of the combination of different polices that discourage private car use. On the other hand, there are a number of transport policies that cause a shift from private to public transport and from own-organized to outsourced transport, leading to an increase in employment in the transport services sector.

There is a distinct increase in magnitude of the effect for the SU scenario compared to the MO scenario. The differences between the Friendly and Tough scenario on the other hand are small.

We now focus on each transport policy measure separately, and analyse the effect on employment for each sector.

Transport equipment sector employment

The effect on employment in the transport equipment sector is largest for the INT and USE policy scenario. In both cases the employment in this sector decreases. In the INT policy scenario the extra taxation on oil reduces transport demand, and this has a negative effect on car sales. It is for this scenario that the effect behaves strongly non-linearly: the effect in the SU case is much larger than in the MO case. The reason is that in the SU case a heavy tax on car sales is introduced that was not yet present in the MO case.

In the USE policy scenario it is the shift of preferences that reduces private transport, reducing the sales of cars as more people no longer require a private vehicle for transportation.

Also in the EFR policy scenario employment decreases in the transport equipment sector. The increased efficiency of freight transport encourages many firms to outsource their transport. This leads to a more efficient use of vehicles, and the outsourcing firms require less vehicles to purchase.

In the FE and ELEC policy scenario the direct effect is an increase of employment in the transport equipment sector because of the extra expenditure on vehicles that stimulates the sector. However, as we saw before these policies have a negative effect on the economy, decreasing overall employment. For most countries the net effect is an increase of employment in the transport equipment sector. Only in Greece, where both the transport equipment and transport services sector are relatively small, the net effect is a decrease of employment in the transport equipment sector.

Finally, in the EE policy scenario the employment in the transport equipment sector decreases. This seems counter-intuitive, since the direct effect for the transport equipment sector is positive: due to energy efficiency increase they have to spend less money on energy, which would allow them to decrease prices and increase sales. However, this is also true for all other sectors. What happens is that other sectors benefit more from this reduction, and increase their sales. They also hire more people, which increases the demand for labour and accordingly the wages. It is this wage increase that in the end increases instead of decreases overall costs for the transport equipment sector, leading to increased prices, reduced sales and reduced employment.

Table 23. Percentage change in employment in transport equipment sector in Friendly scenario

country	pol	EE	FE	ELEC	INT	USE	EFR	FULL
AT	Modernization	-1.09	0.10	0.25	0.64	-0.26	-0.12	-0.49
AT	Sustainability	-1.87	0.20	0.49	0.27	-0.53	-0.32	-1.82
BE	Modernization	-0.20	0.59	1.01	-0.92	-1.30	-0.32	-1.03
BE	Sustainability	-0.35	1.18	2.23	-6.52	-2.59	-0.77	-7.35
DE	Modernization	-0.19	0.57	0.87	-0.40	-1.94	-0.08	-1.26
DE	Sustainability	-0.33	1.13	1.71	-3.34	-3.85	-0.19	-5.18
ES	Modernization	-0.22	0.26	0.68	-0.39	-1.63	-0.06	-1.55
ES	Sustainability	-0.39	0.51	1.34	-10.34	-3.25	-0.15	-12.38
FI	Modernization	-0.21	0.15	0.42	-0.10	-1.06	-0.03	-0.77
FI	Sustainability	-0.43	0.30	0.81	-0.90	-2.00	-0.07	-2.32
GR	Modernization	-0.04	-0.08	-0.06	-1.07	-0.57	-0.29	-2.03
GR	Sustainability	-0.08	-0.13	-0.10	-1.31	-1.20	-0.63	-3.47
PL	Modernization	-0.02	0.09	0.27	-0.15	-0.34	-0.05	-0.21
PL	Sustainability	-0.03	0.17	0.56	-1.93	-0.68	-0.13	-2.08
BG	Modernization	-0.57	0.39	0.52	0.00	-0.74	-0.12	-0.44
BG	Sustainability	-1.19	0.72	1.04	0.00	-1.06	-0.17	-0.86

Table 24. Percentage change in employment in transport equipment sector in Tough scenario

country	pol	EE	FE	ELEC	INT	USE	EFR	FULL
AT	Modernization	-1.07	0.10	0.24	0.63	-0.27	-0.14	-0.51
AT	Sustainability	-1.84	0.19	0.47	0.26	-0.54	-0.33	-1.83
BE	Modernization	-0.21	0.60	1.12	-0.94	-1.28	-0.32	-1.17
BE	Sustainability	-0.36	1.19	2.23	-6.49	-2.54	-0.77	-7.07
DE	Modernization	-0.19	0.57	0.87	-0.45	-1.95	-0.12	-1.25
DE	Sustainability	-0.34	1.14	1.67	-3.37	-3.85	-0.23	-5.14
ES	Modernization	-0.23	0.26	0.61	-0.34	-1.57	-0.06	-0.71
ES	Sustainability	-0.32	0.51	1.40	-10.33	-3.23	-0.14	-12.29
FI	Modernization	-0.22	0.28	0.28	-0.06	-1.15	-0.02	-0.71
FI	Sustainability	-0.27	0.31	0.70	-0.88	-1.87	-0.03	-2.15
GR	Modernization	-0.04	-0.09	-0.06	-0.86	-0.63	-0.36	-2.03
GR	Sustainability	-0.08	-0.22	-0.10	-1.15	-1.24	-0.64	-3.43
PL	Modernization	-0.02	0.08	0.28	-0.16	-0.42	-0.05	-0.11
PL	Sustainability	-0.03	0.16	0.46	-1.91	-0.67	-0.13	-1.96
BG	Modernization	-0.74	0.34	0.50	0.00	-0.50	-0.01	-0.58
BG	Sustainability	-1.34	0.37	1.00	0.00	-0.73	-0.08	-0.99

The differences in effect between the Friendly and Tough scenario are again minimal.

Transport service sector employment

By far the largest effect on employment in the transport service sector takes place in the USE policy scenario, where preferences shift towards the use of public transport. The increased demand for transport services increases the labour demand of that sector. The numbers are so large because we assume a large shift from private to public transport: respectively 10% and 20% of all private car use shifts towards public transport in the MO and SU scenario.

Also the EFR policy scenario has a positive effect on employment in the transport service sector. The direct effect of the administration efficiency gain allows transport service firms to reduce their prices, leading to increased demand for transport and increasing employment in the sector.

In case of the EE policy scenario the employment in the transport services sector decreases due to a similar reasons as for the transport equipment sector: the price of labour increases so much that the price of transport increases, reducing the demand for transport services. As a result the employment in the sector decreases.

In the FE and ELEC policy scenario the employment in the transport services sector increases. In both cases fuel consumption decreases. This decrease in fuel demand decreases fuel prices. Since fuel expenses represent a major expense for transport services, this saving allows them to lower their price and increase sales.

In case of the INT policy scenario transport service firms are more heavily taxed. Because of the increased tax they have to increase their prices, reducing demand for transport services, and leading to less employment in the sector.

Table 25. Percentage change in employment in transport service sector in Friendly scenario

country	pol	EE	FE	ELEC	INT	USE	EFR	FULL
AT	Modernization	-0.33	0.10	0.05	-2.31	4.62	1.67	3.84
AT	Sustainability	-0.57	0.20	0.11	-1.32	9.19	4.06	11.73
BE	Modernization	-0.06	0.06	0.14	-3.56	8.04	2.11	6.60
BE	Sustainability	-0.11	0.11	0.09	-5.34	15.97	5.15	15.73
DE	Modernization	-0.05	0.25	-0.01	-0.69	15.74	1.37	16.76
DE	Sustainability	-0.08	0.49	0.01	-1.66	31.29	3.33	33.56
ES	Modernization	-0.07	0.12	0.20	-2.51	10.43	1.41	9.49
ES	Sustainability	-0.12	0.24	0.12	-3.40	20.76	3.43	21.08
FI	Modernization	-0.02	0.09	0.01	-0.90	5.90	0.13	5.28
FI	Sustainability	-0.05	0.17	0.03	-4.26	11.83	0.32	7.98
GR	Modernization	-0.01	0.30	0.08	-3.79	14.80	1.06	12.63
GR	Sustainability	0.00	0.60	0.20	-4.00	29.50	2.59	28.89
PL	Modernization	0.05	0.15	0.08	-3.17	5.60	0.31	3.06
PL	Sustainability	0.10	0.30	0.19	-4.53	11.13	0.76	7.91
BG	Modernization	-0.11	0.48	0.14	0.00	4.47	1.19	6.41
BG	Sustainability	-0.12	0.96	0.34	0.00	8.97	2.94	13.43

Table 26. Percentage change in employment in transport service sector in Tough scenario

country	pol	EE	FE	ELEC	INT	USE	EFR	FULL
AT	Modernization	-0.33	0.11	0.06	-2.38	4.60	1.66	3.78
AT	Sustainability	-0.58	0.22	0.13	-1.33	9.15	4.03	11.70
BE	Modernization	-0.06	0.06	0.04	-3.63	7.93	2.08	6.39
BE	Sustainability	-0.11	0.12	0.09	-5.36	15.74	5.07	15.45
DE	Modernization	-0.05	0.33	0.16	-0.65	15.69	1.42	16.67
DE	Sustainability	-0.10	0.58	0.10	-1.60	31.15	3.36	33.53
ES	Modernization	-0.06	0.13	0.14	-2.57	10.39	1.39	9.38
ES	Sustainability	-0.12	0.26	0.10	-3.41	20.62	3.37	20.95
FI	Modernization	-0.04	0.07	0.02	-0.91	5.95	0.12	5.31
FI	Sustainability	-0.07	0.17	-0.01	-4.31	11.68	0.34	7.19
GR	Modernization	-0.01	0.53	0.08	-3.91	14.70	0.99	12.38
GR	Sustainability	0.00	0.57	0.20	-4.11	28.93	2.66	28.26
PL	Modernization	0.05	0.16	0.09	-3.23	5.54	0.31	2.96
PL	Sustainability	0.10	0.33	0.22	-4.54	11.00	0.75	7.86
BG	Modernization	-0.34	0.33	0.52	0.00	4.72	1.51	6.28
BG	Sustainability	-0.13	0.60	0.74	0.00	9.02	3.21	13.17

The differences in effect between the Friendly and Tough scenario are again minimal. In case of the FE and ELEC policy scenario the effect becomes stronger in the Tough scenario as the savings in fuel expenses for the transport service sectors become larger with the increased fuel price in the Tough scenario.

4.4 Total employment effects and employment effects in transport sector

In this section we summarize the changes in employment in the transport equipment and transport service sector in an absolute number of jobs. These results give a more a tangible view on the impact of the proposed transport policies.

The general impact, we repeat this again, is a shift from employment in (transport) manufacturing industries, towards jobs in transport services. The net job creation is significant and is mainly driven by administrative simplification, changes in car use and larger net fuel efficiency.

Table 27. Employment effects in full scenario by country Friendly and Tough scenario in absolute numbers (FTE's)

		Friendly		Tough	
Country	**output_sim**	**ΔMO**	**ΔSU**	**ΔMO**	**ΔSU**
AT	Total jobs created	9,100	15,100	8,309	15,716
BE	Total jobs created	8,100	8,958	7,754	8,600
DE	Total jobs created	59,297	117,327	56,994	114,555
ES	Total jobs created	68,485	120,039	54,523	127,457
FI	Total jobs created	1,465	1,166	161	764
GR	Total jobs created	14,952	20,865	12,269	20,177
PL	Total jobs created	19,578	29,600	18,068	28,150
BG	Total jobs created	5,445	10,730	8,507	11,575
AT	Transp eq jobs created	-300	-1,100	-300	-1,100
BE	Transp eq jobs created	-700	-5,200	-800	-5,000
DE	Transp eq jobs created	-23,900	-98,200	-23,700	-97,500
ES	Transp eq jobs created	-5,300	-42,300	-2,400	-42,000
FI	Transp eq jobs created	-200	-500	-200	-500
GR	Transp eq jobs created	-940	-768	-469	-949
PL	Transp eq jobs created	-500	-5,400	-300	-5,100
BG	Transp eq jobs created	-100	-200	-100	-200
AT	Transp serv jobs created	4,700	14,500	4,700	14,400
BE	Transp serv jobs created	7,600	18,100	7,400	17,800
DE	Transp serv jobs created	152,800	306,100	152,000	305,800
ES	Transp serv jobs created	44,600	99,000	44,100	98,400
FI	Transp serv jobs created	4,300	6,500	4,300	5,900
GR	Transp serv jobs created	11,579	26,878	12,117	27,044
PL	Transp serv jobs created	13,300	34,400	12,900	34,200
BG	Transp serv jobs created	6,800	14,200	6,700	13,900

Below we give the absolute numbers of jobs generated by each particular transport policy scenario. When represented in this way, some remarkable differences become clear between countries and between the different sub-scenarios. While the direction of the change (positive or negative) of each transport policy scenario is (with some exception) the same, for some countries the size of the impact is quite different.

First of all, in none of the countries, electrification had any net positive impact on jobs. The reasons for these are quite complex, but come down to 1) electrical vehicles require less maintenance services with respect to the fixed cost of the car and therefore have a negative impact on service employment 2) they decrease the variable cost of driving, but also the tax income from fuels for the government 3) they do not stimulate the manufacturing sector enough to compensate for job losses elsewhere. The same story, to some degree, is true for gains in fuel efficiency, but here the impact on maintenance is absent, such that the overall impact can be positive for some countries.

As for the transport policies that have the largest impact on employment, these are mainly the energy efficiency (EE), reduced use of private transport (USE), e-Freight (EFR) and internalization of external cost (INT) scenario. As already mentioned, the impact of these scenarios varies considerably in relative terms, by country. For example, in Austria (AT) the energy efficiency scenario creates the largest share of job growth, while in Germany (DE) it is about a third of the net job creation. e-Freight (EFR) has a very large impact in Spain (ES) (+-40% of the total gain), but the net impact in other countries is much more modest, though in general positive (with the exception of Greece (GR)). In the Greek case the loss in administrative jobs seemed to outweigh the impact elsewhere. We are not certain if this is entirely representative, but it was a robust effect in all simulations. The job growth of the internalization (INT) scenario is mainly situated in public jobs, as the tax revenue is recycled by the government on the domestic economy. Only in Finland (FI) did this have a structurally negative effect. Without the INT scenario, the overall net job effect would be more positive for Finland.

The USE scenario has a large impact, especially in Germany (DE) and Poland (PL). In Spain (ES) this was negative, as it led to a relatively larger share of job losses in car manufacturing and other manufacturing sectors. Job gains in public and other related transport services were not enough to compensate for this.

There is no large difference between the friendly and tough scenarios, except that the though scenario seems to be a little more reactive in terms of job growth. The reason for this is that the reference unemployment is higher in the tough scenario, which makes some transport policy scenarios more effective.

Table 28. Employment effects in friendly scenario, by transport policy scenario, absolute numbers (FTE's)

Country	pol	EE	FE	ELEC	INT	USE	EFR	FULL
AT	Modernization	7,460	-34	-173	848	257	520	9,100
AT	Sustainability	12,354	-77	-377	1,015	533	1,256	15,100
BE	Modernization	674	662	-304	3,375	1,681	2,352	8,100
BE	Sustainability	1,157	1,294	-356	-1,532	3,333	5,636	8,958
DE	Modernization	19,639	-1,577	-4,406	9,549	32,782	4,129	59,297
DE	Sustainability	33,667	-3,224	-7,520	19,382	66,124	10,273	117,327
ES	Modernization	42,315	216	-13,005	12,251	-5,018	21,946	68,485
ES	Sustainability	73,101	450	-9,531	23,857	-10,222	52,768	120,039
FI	Modernization	1,069	-38	-29	-292	653	183	1,465
FI	Sustainability	2,022	-15	-80	-2,998	1,467	534	1,166
GR	Modernization	1,204	-1,205	-413	9,185	7,768	-1,653	14,885
GR	Sustainability	1,726	-2,461	-940	11,545	15,144	-4,223	20,790
PL	Modernization	6,027	-6,365	-3,492	13,161	8,925	1,240	19,578
PL	Sustainability	10,449	-12,249	-7,251	15,026	17,783	2,996	29,600
BG	Modernization	4,575	-371	-433	0	1,172	914	5,445
BG	Sustainability	8,423	-714	-1,650	0	2,178	2,211	10,730

Table 29. Employment effects in tough scenario, by transport policy scenario, absolute numbers (FTE's)

Country	pol	EE	FE	ELEC	INT	USE	EFR	FULL
AT	Modernization	7,076	47	-205	649	408	460	8,309
AT	Sustainability	12,594	28	-389	924	792	1,203	15,716
BE	Modernization	738	688	38	2,990	1,698	2,388	7,754
BE	Sustainability	1,253	1,325	-426	-2,448	3,304	5,643	8,600
DE	Modernization	20,236	-1,494	-7,944	8,273	29,857	2,596	56,994
DE	Sustainability	34,589	-4,921	-8,675	18,111	60,444	8,456	114,555
ES	Modernization	43,683	488	-2,736	10,174	-5,325	22,248	54,523
ES	Sustainability	72,875	717	-7,998	17,304	-8,442	52,339	127,457
FI	Modernization	334	9	-78	-305	35	38	161
FI	Sustainability	2,383	100	-51	-4,682	1,456	479	764
GR	Modernization	1,500	-2,053	-357	8,049	6,849	-1,145	12,360
GR	Sustainability	1,615	-2,546	-960	11,712	15,075	-4,876	20,177
PL	Modernization	5,420	-6,159	-4,071	12,232	9,923	1,233	18,068
PL	Sustainability	9,744	-12,661	-6,689	14,059	19,859	3,088	28,150
BG	Modernization	5,522	-573	-374	0	1,599	1,855	8,507
BG	Sustainability	7,341	229	168	0	1,238	1,745	11,575

5. Conclusions

This deliverable contains the results from the EDIP model, based on the scenario descriptions of D15.1. On the basis of the NEUJOBS modelling approach we develop 6 scenarios for 2030, focussing on developments in the transport sector to tackle the socio-economic transition. The results of D15.2 are oriented towards the macro-economy and we report the changes in a series of structural indicators on economic, social and environmental dimension.

The results presented range across 5 macro-regions: Northern, Nordic, Continental, Eastern and Southern Europe. In total 8 countries have been selected, fitting within each of these macro-regions. These results can, to some degree, be generalized for the EU, but a full review for all EU countries was not possible within this study, due to the complexity of the scenarios and the time to analyse and verify the results for each country.

We distinguish 2 background scenarios (friendly and tough) and 3 main policy scenarios, ('status quo', 'modernization' and 'sustainability'). The background scenarios are elaborate and represent changes in a number of important economic parameters of each country. Each policy scenario consists of 6 sub-scenarios (transport policy scenarios), targeted at different parts of mobility. These transport policy scenarios are related to fuel and energy efficiency, electrification of the transport fleet, congestion and kilometre charging for passenger and trucks, promotion of public transport use and administrative simplification caused by e-Freight. We presented results for each combination of transport policy and background scenario and then displayed detailed reports for the impact of each transport policy scenario.

The proposed transport policies were evaluated not only on their effect on employment, but also on other indicators such as environmental impact. Our main conclusion is that a move to the proposed sustainability oriented policies can reduce emissions of greenhouse gasses and related pollutants by around 1-9%[6], with low costs in terms of GDP and employment. In fact, in general the impact on GDP and employment is positive. For the combination of all transport polices the increase in GDP is around 0.5%, with a range between 0.04% and 1.19%. The employment rate increases about 0.25%, with a range between 0.02% and 0.57%. This positive effect is important because one of the main obstacles for introducing policies that reduce emissions is fear for loss of employment and reduced GDP. For similar reasons we also look at other indicators: policy decisions generally face a trade-off between different goals. In all countries there is a net job creation under the modernization and sustainability conditions, which increases when moving closer towards the full sustainability (SU) scenario. About half of the reductions in greenhouse gas emissions are caused by an increase in energy efficiency, the rest are caused by a reduction in the use of private mobility. Increasing fuel efficiency of transport in itself is shown not to be very effective in the reduction of emissions, as the reduction in variable cost of driving leads to an increased demand of mobility, largely offsetting the gain in fuel efficiency. This is also known as a rebound effect.

Electrification of the fleet is beneficial for environment, but one should still be careful with the impact on the use of mobility, as congestion and other externalities such as safety are negatively affected. Therefore the interaction between the fuel efficiency, electrification and congestion charging (such as proposed in the IMPACT study (Van Hessen H.P et al, 2008) is important to consider as a driver for a reduction in the externalities of transport.

On the side of the labour market, we clearly see that in all countries where the proposed transport policy measures are introduced, employment shifts towards transport services

[6] The range of the overall reduction in emissions per capita in the sustainability scenario.

instead of transport manufacturing. In our sustainable world less people are driving and buying cars, but more are employed as an operator of any type of public transport. This is caused by the combined effect of more expensive private transport caused by the introduction of congestion and distance charging based systems and a shift in preferences towards public transportation. This shift is only partially counteracted by a reduction in the variable cost of driving due to electrification of transport and increased fuel efficiency. The net job creation of the combined policy effects in all countries in this study is positive and is especially large in Spain (ES) and Germany (DE) when implementing the sustainability (SU) policies.

For individual transport policy scenarios, we see that promoting fuel efficiency and electric vehicles is not immediately stimulating net employment growth, at least not under the specific scenarios used in NEUJOBS. Especially electric vehicles are not promising in this respect. Transport policies that drive job growth are the e-Freight measures (and other measures reducing the administrative cost of freight transport), overall gains in energy efficiency, reducing the use of private transport by promoting public transport and internalization of external cost of driving.

As a main caveat with the job creation results, we wish to say that no policy should be accepted or dismissed on the impact on employment alone. This deliverable contains a full analysis of economic, social and environmental indicator, which should also be taken into account when considering a real policy option.

Please note that while the NEUJOBS scenarios represent quite important shifts in the economy, even these scenarios will not be able to internalize all economic shifts that may happen in the next 2 decades. Still we see in our results, that the added effect of each implemented transport policy is quite similar under different background conditions (tough or friendly). In real world conditions, this may not catch the attention as the individual effects of each policy would get lost in the impact of the background scenario.

In deliverable D15.3 we will make a similar analysis as has been done in this paper, but on a smaller scale: we will focus on changes in the organization of cities, public transport, technological evolution of transport and transport taxation policy. The present paper should be seen as the macro-economic parallel D15.3.

References

Autor David H., 2002, Skill biased technical change and rising inequality: “What is the evidence? What are the alternatives?”, MIT research institute working paper

Blanchflower, David G. & Oswald, Andrew J., 2005, The Wage Curve Reloaded, IZA Discussion Papers 1665, Institute for the Study of Labor (IZA).

Gruning M, Witte M., Marcellino D., Selig J., 2011, CE Delt: Impacts of electric vehicles – Deliverable 1: An overview of electric vehicles on the market and in development

Ottaviano P. & Peri G., 2006. "Rethinking the Effects of Immigration on Wages," NBER Working Papers 12497, National Bureau of Economic Research, Inc

Ottaviano P. G, Peri G., D’Amuri F., 2008, The labour impact of immigration in Western Germany in the 1990’s. Institute for social & economic research, ESSEX university.

Prudhomme, R. (2010, November). Electric Vehicles: A Tentative Economic and Environmental Evaluation. Discussion Paper 2010-22 Paris: France International Transport Forum - OECD Publishing.

Pikul, James H., Hui Gang Zhang, Jiung Cho, Paul V. Braun ,William P. King, 2013, High-power lithium ion microbatteries from interdigitated three-dimensional bicontinuous nanoporous electrodes, Nature Communications, Article 1732, doi: 10.1038/ncomms2747

Rutherford T., 2002, Lecture notes on constant elasticity functions, University of Colardo.

Van Dender K, 2011, What does improved fuel economy cost to consumers and what does it cost to society? Paper prepared for the international transport forum.

Van Essen H.P, Boon B.H, Otten M., Maibach M, Schreyer C., Doll C., Jochem P., Bak M., Pawlowska B., 2008, Internalization measures and policy for the external cost of transport, IMPACT study

Wing I., 2003, Computable General Equilibrium Models and Their Use in Economy-Wide Policy Analysis: Everything You Ever Wanted to Know (But Were Afraid to Ask), (Unpublished). http://people.bu.edu/isw/papers/cge.pdf

A. Appendix

A.1 Description of the EDIP model

The socio-economic model called the European Model for the Assessment of Income Distribution and Inequality Effects of Economic Policies (EDIP) is constructed using the Computable General Equilibrium (CGE) framework, which takes as a basis the notion of the Walrasian equilibrium. Walrasian equilibrium is one of the foundations of the modern micro economics theory. CGE models are a class of economic models that use actual economic data to estimate how an economy might react to changes in policy, technology or other external factors. A model consists of (a) equations describing model variables and (b) a database (usually very detailed) consistent with the model equations. The EDIP model is based on the most recent publically available social, economic, environmental transport and energy data and the public version of the WIOD database. The EDIP database covers EU28 countries, Norway, Switzerland, and Turkey.

The model equations tend to be neo-classical in spirit, assuming cost-minimizing behavior by producers, average-cost pricing, and household demands based on optimizing behavior. A CGE model database consists of tables of transaction values and elasticities: dimensionless parameters that capture behavioral response. The database is presented as a social accounting matrix (SAM). It covers the whole economy of a country, and distinguishes a number of sectors, commodities, primary factors and types of households.

The EDIP model has a single mathematical formulation for all European countries. It is one model with 31 different versions, which are estimated using the country-specific dataset. The main element of the country-specific dataset of the EDIP model is the Social Accounting Matrix (SAM), which represents the annual monetary flows between different economic agents for the year 2007. Structure of the SAMs does not differ between the countries and corresponds to the overall structure of the EDIP model. Other country-specific data includes the socio-economic data related to different household types, labor market data, transport data, energy and emissions data. The EDIP model uses the latest available data from different statistical sources including EuroStat, national statistical offices, International Labor Organization, OECD, IEA etc.

CGE models utilize the notion of the aggregate economic agent. They represent the behavior of the whole population group or of the whole industrial sector as the behavior of one single aggregate agent. It is further assumed that the behavior of each such aggregate agent is driven by certain optimization criteria such as maximization of utility or minimization of costs.

The EDIP model includes the representation of the micro-economic behaviour of the following economic agents: several types of households differentiated by 5 income quintiles, production sectors differentiated by 59 NACE95 classification categories; investment agent; federal government and external trade sector. Each household group in the EDIP model consists of the individuals differentiated by three types of education levels and ten types of professions. The composition of households is based on the extensive socio-economic dataset for the year 2009 and microdata from the SILC database.

The EDIP model is a dynamic, recursive over time, model, involving dynamics of capital accumulation and technology progress, stock and flow relationships and backward looking expectations. A recursive dynamic structure composed of a sequence of several temporary equilibriums. The first equilibrium in the sequence is given by the benchmark year. In each time period, the model is solved for an equilibrium given the exogenous conditions assumed for that particular period. The equilibriums are connected to each other through capital accumulation. Thus, the endogenous determination of investment behavior is essential for the dynamic part of the model. Investment and capital accumulation in year t depend on expected rates of return for year t+1, which are determined by actual returns on capital in year t.

Behaviour of the households is based on the utility-maximization principle. Household's utility is associated with the level and structure of its consumption. Each household spends its consumption budget on services and goods in order to maximize its satisfaction from the chosen consumption bundle. Households have substitution possibilities between different consumption commodities. They can substitute consumption of transport for the consumption of other goods and services. They are also able to substitute between their consumption of electricity and other energy types such as gas, coal and refined oil. The inclusion of substitution possibilities is important for a realistic representation of the consumption decisions of the households and better assessment of the welfare and economic effects of transport and energy policies.

Utility of the household is maximized under the budget constraint, where the household's consumption spending is equal to its income minus income tax and the household's savings. Households in the EDIP model receive their income in the form of wages, capital rent, unemployment benefits and other transfers from the federal government. The level of the unemployment benefits, received by the household, depends upon the level of unemployment associated with the particular education level and occupation type of the individuals within the household.

The levels of the wages earned in different sectors of the economy by individuals with different education levels and occupation types are determined by the national-level bargaining process between the sector-specific trade union and the firms within this sector. Firms share partially their profits with their employees by paying them wages, which are higher than their marginal product of labor.

Behavior of the sectors is based on the minimization of the production costs for a given output level under the sector's technological constraint. Production costs of each sector in the EDIP model include labor costs by type of labor, capital costs and the costs of intermediate inputs. The sector's technological constraint describes the production technology of each sector. It provides information on how many of different units of labor, capital and of the 59 commodities, traded in the economy, are necessary for the production of one unit of the composite sectoral output.

In accordance with their production technology, sectors have substitution possibilities between different intermediate inputs and production factors. They can substitute between the use of different education types and between different occupations within each education type. They are also able to substitute between their consumption of electricity and other energy types such as gas, coal, oil and refined oil. Existence of the technological substitution possibilities is an important feature of the production process and cannot be neglected while modeling sectoral production.

Each sector in the economy may produce more then one type of commodity and the combination of these different commodities corresponds to the sectoral composite output. Production output of each sector can be either delivered to the domestic market or exported to EU25 trade zone or to the rest of the world. Each sector determines the shares of its outputs, sold domestically and exported, based on the profit maximization principle. It takes into account the relative prices of the same type of commodities in its own country and abroad.

An Armington assumption on international trade is adopted in the model. According to this assumption the commodities produced by the domestic sectors for the consumption inside the country and for the consumption outside of it have different specifications. In order for the sector to be able to switch its technological process between producing these two different specifications of commodities, it has to overcome some adjustments. The degree of difficulty and feasibility of such adjustment is represented by the constant elasticity of transformation (CET) elasticity of substitution between producing commodity for the domestic use, for export to the EU25 and for the export to the rest of the world. The higher is this elasticity of substitution the more feasibly and easy the adjustment technological process described above. Than the proportions, in which the total output of each sector is split between the three possibilities, depend not only upon the relative prices of the commodities inside the country and on the world market but also upon the CET elasticity of substitution.

Domestic sales of each of the 59 types of commodities composed of the commodities produced by the domestic sectors, those imported from the EU25 and those imported from the rest of the world. According to the Armington assumption, the same type of commodity produced by the domestic sectors, imported from the EU25 or imported from the rest of the world has different specifications and, hence, cannot be treated as a homogenous good. Domestic consumers have different preferences for these three specifications and can substitute between them in case the relative prices of the specifications change. The substitution possibilities between these three commodity specifications are represented by the Armington elasticity of substitution and vary between the types of commodities. The shares in which commodity is bought from the domestic producers, from the EU25 and from the rest of the world are determined by the relative producer prices of the commodity inside the country, in EU25 and in the rest of the world as well as by the Armington elasticity of substitution.

The equilibrium prices of all commodities and capital are defined by the market equilibrium conditions. Under the market equilibrium the sum of demands for a particular commodity is equal to the sum of its supplies. Due to the existence of unemployment and wage bargaining on the labor market, it is in disequilibrium. The level of the wages is determined by the bargaining process between the trade unions and firms. It depends positively upon the probability to find a new job and the firms' profits.

The model incorporates the representation of investment and savings decisions of the economic agents. Savings in the economy are made by households, government and the rest of the world. The total savings accumulated at each period of time are invested into accumulation of the sector-specific physical capital, which is not mobile between the sectors. The stock of this capital at each period of time is equal to the last period stock minus depreciation plus the new capital accumulated during the previous period of time.

The total investment into the sector-specific capital stock is spent on buying different types of capital goods such as machinery, equipment and buildings. The concrete mixture of different capital goods used for physical investments is determined by the maximization of the utility of the investment agent. This is an artificial national economic agent responsible for buying capital goods for physical investments in all the domestic sectors.

The EDIP model incorporates the representation of the federal government. The governmental sector collects taxes, pays subsidies and makes transfers to households, production sectors and to the rest of the world. The federal government consumes a number of commodities, where the optimal governmental demand is determined according to the maximization of the governmental consumption utility function. The model incorporates the governmental budget constraint. According to this constraint the total governmental tax revenues are spend on subsidies, transfers, governmental savings and consumption.

Finally, the model includes the trade balance constraint, according to which the value of the country's exports plus the governmental transfers to the rest of the world are equal to the value of the country's imports.

Households and domestic sectors use transport services in their consumption and production activities. The transport services represented in the EDIP model are differentiated by the two distance classes (below 500km and above 500km) and all main types of transport modes (land, water and air). Each type of transport service is associated with the particular after tax price, which includes VAT taxes and other taxes. Public transport and freight transport services are produced by several national transport sectors. These sectors use labor, capital and commodities, for example fuels and vehicles, as inputs to their production. Passenger transportation by car is produced by the households and firms themselves using fuel and car vehicles. In order to have a passenger car vehicle a household has to pay the car ownership costs, which include different types of taxes, such as registration taxes, for example.

The EDIP model employs the concept of a variable expenditure function with quasi-fixed durable goods (car vehicles) as arguments in order to derive a demand system for nondurable goods (fuels) in prices of the nondurables, in the stocks of durables and in variables expenditure. Investment demand for durables and their desired stocks (car stocks) are determined inside the model. The desired stock of cars in the EDIP model depends upon the development of the demand for transportation and the car ownership costs.

All production and consumption activities in the EDIP model are associated with emissions and environmental damage. This is in particular true for the transportation. The model incorporates the representation of all major greenhouse gas and non-greenhouse gas emissions. Emissions in the EDIP model are associated either with the use of different energy types by firms and households or with the overall level of the firms' outputs.

Environmental quality is one of the main factors of the households' utility function. Changes in the levels of emissions have a direct impact upon the utilities of the households. Different income classes in the model are influenced differently by the changes in emission levels of various pollutants. Local pollutants have more impact upon the poor household groups, who live closer to the industrial sites and areas with dense traffic. The evaluation of emissions by each household group depends upon its willingness-to-pay. It is assumed that the willingness-to-pay is closely correlated with the income of the household. Rich households put a higher value to the emissions then the poor ones. The willingness-to-pay of the households is determined endogenously in the EDIP model and influences their respective welfare function.

The welfare of each household type (population group) in the EDIP model is calculated as the equivalent variation measure and depends upon consumption of commodities and the level of emissions. The EDIP model has broad coverage of different socio-economic types of individuals and households. That allows it to compute the effects of transport and energy policies on different population groups including the five income quintiles, three education levels and ten occupation types.

The model also calculates a set of the inequality and poverty coefficients including the Gini coefficient, the GE family of inequality indexes and the Foster-Green Thorbecke family of poverty indexes. The EDIP model has detailed commodity and sectoral disaggregation and includes the representation of 59 sector/commodity types according to the NACE95 classification of EuroStat. The sectoral disaggregation of the model includes three transportation sectors: land, water and air. Production technology of these three sectors is represented in great detail in the model.

Thorough sectoral disaggregation of the EDIP model allows one to assess sector-specific impacts of the transport and energy policies in great detail and provides its users with useful insights into the channels, through which policy measures influence the economies of the European countries.

Besides the representation of the transport-related taxes, the EDIP model also includes all other major taxes and subsidies in the economy. It represents both the governmental spending and governmental budget in detail. Governmental spending includes its transfers to different income quintiles besides others. This particular model feature makes it possible for the user to assess the combined effect of measures, related to different policy areas. For example, it allows one to combine an increase in the fuel tax with higher governmental transfers to poor income groups. The model user can analyze not in only in which way it is the best to collect transport and energy-related tax revenues but also in which way it is the best to spend them.

The EDIP model is well suited for the assessment of a wide range of energy, transport, economic and social policies. The model allows for the calculation of broad welfare and macro-economic effects of the policies as well as their sector-specific and labor market effects.

The model can help with an evaluation of both separate measures and packages of policies. Despite its broad nature, the main focus of the EDIP model is an assessment of impact of transport-related policies on inequality and income distribution in the economies of European countries.

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

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