The REFIT framework for the Assessment of European Transport Policies

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ABSTRACT

In current practice of transport policy three weaknesses can be identified: Firstly, the links between existing modelling tools and sustainability indicators are inadequate. Secondly, the existing modelling toolbox is incomplete, especially with respect to the impact of transport policies on regional economic growth, on social equity and on local environmental quality. Finally, there has been a tendency to address measures in isolation without an understanding of interdependencies between measures. REFIT is a project co-funded by the European Commission within the Sixth Framework programme that tries to repair these weaknesses producing a comprehensive methodology for assessing the impact of various transport policies and strategies on sustainability. The objective of the REFIT study is to develop a comprehensive assessment framework that links European transport policy objectives and indicators to the growing pool of tools and expertise accumulated within various European research projects.

The framework is based on the application of modelling tools, which are used to produce a wide set of output, which in turn are processed to derive a set of indicators belonging to different domains. Within REFIT study Europe-wide transport models (TRANS-TOOLS and TREMOVE) have been combined with three models created ad-hoc for calculating specific indicators that are able to cover the economic, the environmental and the social dimension of transport system sustainability.

The economic module addresses the linkages between transport and economy, mainly in terms of the effects of transport policy measures on regional GDP or employment; the

environmental module, deals with health impacts of air-pollution and traffic noise; the social module handles the effects of policies on the social side in terms of aspects like the distribution of costs and benefits.

Selected outputs from the models are collected for the calculation of four groups of sustainability indicators: transport system indicators, transport economic impact indicators, transport environmental indicators and transport social indicators. These indicators are either derived from the international literature or suitably created for REFIT project.

The REFIT methodology has been tested on a set of transport charging policies for the internalisation of external costs where the indicators allowed for highlighting some important trade-offs between them.

The REFIT framework for the Assessment of European Transport Policies

INTRODUCTION

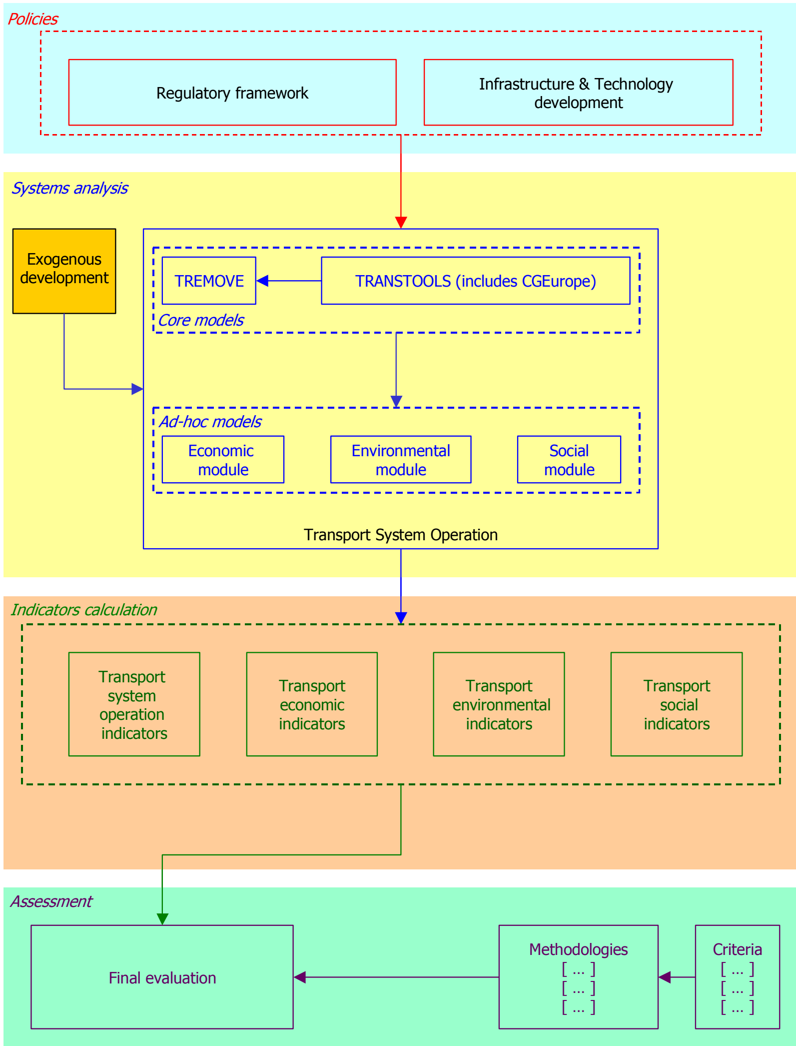
In current practice of transport policy three weaknesses can be identified: Firstly, the links between existing modelling tools and sustainability indicators are inadequate. Secondly, the existing modelling toolbox is incomplete, especially with respect to the impact of transport policies on regional economic growth, on social equity and on local environmental quality. Finally, there has been a tendency to address measures in isolation without an understanding of interdependencies between measures. REFIT[1] is a project co-funded by the European Commission within the Sixth Framework programme that tries to repair these weaknesses producing a comprehensive methodology for assessing the impact of various transport policies and strategies on sustainability. The objective of the REFIT study is to develop a comprehensive assessment framework that links European transport policy objectives and indicators to the growing pool of tools and expertise accumulated within various European research projects. The project has involved several partners from European countries: Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (TNO-Netherlands), Trasporti e territorio (TRT-Italy), Transport and mobility Leuven (TML-Belgium), Istituto di studi per l'Integrazione dei Sistemi (ISIS-Italy), Chiristian-Albrechts-Universität zu Kiel (CAU-Germany), Universität Stuttgart, Institut für Energiewirtschaft und Rationelle Energieanwendung (USTUTT-Germany).

[1] REFIT-Refinement and test of sustainability and tools with regard to European Transport policies

THE REFIT ASSESSMENT FRAMEWORK

The REFIT project aims to develop, test and validate a “modelling tools-based” methodology that, through the analysis of selected indicators, enables ex-ante evaluation of the European Common Transport Policy considering the economic, environmental and social dimensions of sustainability.

The starting point is the definition of the transport policy, which constitutes the input for the modelling tools, under form of assumptions on the value/state of a set of variables (the policy leverages of the models). The modelling tools are formed by the *core* models and the *ad-hoc* models and their main role is to produce sustainability indicators to provide synthetic measures of the effects of transport policies on given domain. Indicators are policy sensitive in the sense that their ingredients include variables whose value is affected by the policy implementation. The effect of specific measures is generally reflected by a change of the value or one or more indicators.



The figure above shows the main components of the operational framework; it includes four main areas, which are described in detail below.

The "Policy" area includes the leverages that are used to design the transport policies. On the one side, leverages may modify the regulatory framework of the transport system. The term "regulatory" is used here in a wide sense to include not only elements like market regulation (e.g. open rail market to competition), but also measures which affect directly transport costs like road pricing or environmental taxation, etc. On the other side, policies can include measures concerned with the 'hardware' side, that is the improvement of infrastructures (e.g. the implementation of new roads and rails on TEN corridors) as well as the technological development (e.g. reduced emissions of pollutants from transport modes). From a conceptual point of view, the definition of a policy implies a “change of assets” which might be either positive (the creation of new assets, e.g. new transport infrastructures) or negative (resource consumption, which is a reduction of assets). The Policy area provides inputs to the core and ad-hoc models of the “Transport System Operation” box within the System Analysis area.

This area is the ‘engine’ of the operational framework, where the input defined in the Policy area is translated into raw output which will serve to compute the indicators. The main element in this area is the “Transport System Operation”, which includes:

- the core models, Trans-Tools and TREMOVE, and

- the ad-hoc models, which produce sustainability indicators respectively for the economic, environmental and social dimension.

Another component of this area is the definition of the “Exogenous development”. It includes all those trends which are relevant to define the mobility patterns although these are not part of the transport system (e.g. economic growth, population development, etc.) and also out of control of the European transport policy maker. Assumptions concerning such exogenous elements enter as input in the modelling tools and allow them to provide forecasts about the development of transport demand and its effects.

The System Analysis area produces a wide range of quantitative results. Such results are transferred to the Indicator Processing area for the calculation of the sustainability indicators, which are either derived from the international literature or suitably created for REFIT project. The indicators are grouped by topic: transport system operation indicators, transport economic impact indicators, transport environmental indicators and transport social indicators. In some cases, the modelling output is directly translated into indicators while in other cases additional processing is needed. Therefore, even if the ‘heart’ of the quantification of impacts of the policies is in the System Analysis area, the Indicator Processing area plays a key role as well. The produced indicators provide the basis for the assessment phase carried out in the last area of the operational framework.

The Assessment area is the place where the indicators developed in the previous steps of the operational framework can be used to derive a final response concerning the impacts of the transport policies on the sustainability. In REFIT is explicitly recognised that the measurement of the impacts of transport policy requires a multidimensional approach. Therefore the different domains (economy, environment and society) are considered and within each domain a wide range of indicators is available. The Assessment area addresses the task of using the whole set of indicators in order to obtain a synthetic measure of sustainability.

Therefore, in this area the values of the indicators are collected into the REFIT operational tool: it is the instrument where the indicators are gathered in a coherent way in order to provide the policy makers with a clear overview of the indicators and their individual and total response to a certain transport policy. It contains policies description and implementation, output of the models, indicators values of the policy grouped by domain, indicators values of the policy compared to base case and additional information for the assessment.

THE MODELLING TOOLS

Modelling tools represent the instruments to simulate the effect of the transport measures that is to measure the change induced by a policy on a wide range of variables. As already mentioned, the REFIT "tool box" includes the two *core* models and three modules created *ad-hoc* to analyse specific aspects, which are not addressed by the two main models in sufficient detail by the core models with respect to the economic, environmental and social dimension.

The Trans-Tools/TREMOVE integrated model structure is the *core* of the quantitative procedure: Trans-Tools is a network-based transport model whereas TREMOVE simulates aggregate demand and includes a detailed description of fleet development, fuel consumption and emissions factors. They simulate the change induced by a policy on a wide range of variables and produce a set of data which are either indicators themselves or the input of the *ad-hoc* models.

Indicatively: the economic module addresses the linkages between transport and economy, mainly in terms of the effects of transport policy measures on regional GDP or employment; the environmental module, deals with health impacts of air-pollution and traffic noise; the social module handles the effects of policies on the social side in terms of aspects like the distribution of costs and benefits.

The Trans-Tools model

Trans-Tools is a European transport network model covering both passenger and freight, as well as intermodal transport. It's made of different modules, which exchange information according to a sequential approach. The main sub-models are:

- freight demand model;

- passenger demand model;

- assignment models.

The different models are linked applying a number of conversion routines. The model framework allows feedbacks between the sub-models to achieve equilibrium between supply and demand. All model components are integrated into ArcGIS, which allow the user to edit, operate and illustrate results from the same common GIS-based platform.

The *freight demand* is analysed in three steps: the trade model generates the matrices by updating the ETIS origin/destination freight transport matrix which is used as an analogue substituting of the trade relations matrix; the modal split model performs the mode choice by estimating the market shares of the different modes of transport for every O/D relation and commodity group; the logistic model makes it possible to evaluate the impacts of changes in the logistic and transport systems within Europe on the spatial patterns of freight transport flows, through changes in the number and location of warehouses for the distribution of goods.

The *passenger demand model* tackles passenger transport modelling at European level, and covers the first three steps of the classic four-step-approach, which are trip generation, trip distribution and modal split.

Trip generation is modelled following the ASTRA[2] and SCENES approach: passenger trip rates reflect the various specific patterns of trip making behaviour of different population segments disaggregated by NUTS 3 zone (1270 zones), age classes, employment status, car-ownership status and three trip purposes: business, private and tourism. After the generation, these trips are distributed among destinations in the trip distribution process, that requires the average generalized times which in turn depend on the modal split stage results, through a feedback mechanism.

In the third step the mode for the travel is chosen: travel costs, travel time and information about the trip itself, like frequencies and number of transfers, are used to split the trips between the modes. Subsequently, for each origin/destination pair, the modal split model uses

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[2] SCENES European Transport Forecasting Model and Appended Module: Available on the Internet: http://www.iww.uni-karlsruhe.de/SCENES. A detailed documentation of the VACLAV model is reported by Schoch (Schoch, 2004). A detailed description of the ASTRA model is provided by SCHADE (2004), available on the internet: http://www.iww.uni-karlsruhe.de/ASTRA/summary.html

a non-linear logit function to calculate the probability of selecting a modal alternative out of a set of available modes.

The *network assignment module* produces the direct output from the Trans-Tools model. However, the models also generate level-of-service data (LoS) as input to passenger, freight, and logistic models in a feed back loop. In the TRANS-TOOLS model, transport networks are defined at unimodal level and the following assignment models are developed:

- road network (passenger and freight);

- rail network (passenger and freight);

- inland waterway (freight);

- air network (passenger).

The TREMOVE model

TREMOVE[3] is a transport and emissions simulation model developed for the European Commission. It is designed to study the effects of different transport and environment policies on the emissions of the transport sector. The model, which covers all relevant transport modes, estimates the transport demand, the modal split, the vehicle fleets, the emissions of air pollutants and the welfare level under different policy scenarios. It covers the 1995-2020 period, with yearly intervals.

The strength of the model is that it also enables to assess the effects of environmental policies on future vehicle fleets and on overall transport demand and its modal split. The calculated welfare effect of a policy then is not only determined by technology costs and emission

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[3] More information on www.tremove.org

reductions, but also by effects on household mobility, industry logistic processes and government tax income from the transport sector.

TREMOVE consists of three inter-linked ‘core’ modules: a transport demand module, a vehicle turnover module and an emission and fuel consumption module, to which a welfare cost module and a life cycle emissions module has been added.

The transport demand module describes transport flows and the users’ decision-making process when it comes to making their modal choice. Starting from the baseline level of demand for passenger and freight transport per mode, the module describes how the implementation of a policy measure (or a package of measures) will affect the baseline allocation of demand across different modes and different vehicle categories.

The output of the demand module consists in passenger kilometres (pkm) and ton kilometres (tkm) that are demanded per vehicle category for a given policy environment.

The vehicle stock turnover module describes how changes in demand for transport across modes or changes in price structure influence the number, the age and the type of vehicles in the stock. For each vehicle category, the evolution of the detailed vehicle fleet and the related number of vehicle-km is estimated. The vehicle stock module has been calibrated using historical data on the vehicle stocks in the countries considered.

The fuel consumption and emissions module is used to calculate fuel consumption and emissions, based on the structure of the vehicle stock, the number of kilometres driven by each vehicle type and the driving conditions. Outputs from the vehicle stock and fuel consumptions and emissions modules are fed back into the demand module: as fuel consumption, stock structure and usage influence usage costs and are important determinants of transport demand and modal split.

The TREMOVE model includes a lifecycle emissions and a welfare cost module. The *lifecycle emissions module* enables to calculate emissions during production of fuels and electricity. Thus, the TREMOVE model does not only take into account operational vehicle emissions, but also those due to production of fuel and electricity.

The *welfare cost module* has been developed to compute the cost to society associated with emission reduction scenarios in European urban and non-urban areas. The welfare effect of a policy change is calculated as the discounted sum of changes in utility of households and costs of production, and benefits of tax recycling. These benefits of tax recycling represent the welfare effect of avoiding public funds to be collected from other sectors, when the transport sector generates more revenues. External costs of congestion and pollution are also included in the welfare cost.

The economic model

The economic model, CGEurope-R, is a multi-regional computable general equilibrium model covering the whole world. Computable General Equilibrium models are a class of economic model that use actual economic data to estimate how an economy might react to changes in policy, technology or other external factors.

CGEurope-R model is essentially neoclassical in nature with two important deviations. First, the production structure is similar to that common to the new economic geography literature, with two sectors: local goods, characterized by perfect competition, and tradable goods, characterized by monopolistic competition, with each firm producing a different variant of a good. The consumer demand is correspondingly characterized by the “love for variety”. Another important deviation from the perfectly competitive markets is the labour market characterized by a certain degree of wage rigidity. The country-specific values of the unemployment elasticity of pay are taken from the rich “wage curve” literature.

The feature that allows the model to assess impacts of transport policies is the explicit incorporation of interregional trade costs. The changes in these costs, occurring for example due to the implementation of a certain road-pricing scheme, would affect relative prices that the economic agents face, and in the general equilibrium framework that will give rise to the whole series of interdependent adjustments of trade flows, production and income in all model regions.

Two components of trade costs are introduced: travel costs or costs related to geographic distance, and costs for overcoming impediments to international trade. The values for the international trade impediments are calibrated within the model and include tariffs (not relevant within EU anymore), but also, and more important, all costs stemming from non-tariff barriers, like costs due to language differences, costs of bureaucratic impediments, time costs spent on border controls and so forth.

An important component of the model is the capital mobility. This feature allows the effects of policy change on regional GDP and regional income (later approximating the welfare effects) differ quite substantially, because the domestic owners of capital are allowed to invest abroad, when they are seeking higher returns.

The most important results for policy assessment generated by comparative static analysis using CGEurope-R are the monetary measures of regional welfare effects of the evaluated projects. They convert utility gains of regional households to monetary amounts by the concept of equivalent variation. For small changes, relative equivalent variation approximately equals the change in the log real income compared to the do-nothing scenario.

The environmental model

An ad-hoc environmental model has been produced within the REFIT project for modelling the percentage of the urban population (per country) in the EU that is exposed to a concentration of NO2 or PM10 that is exceeding EU limit values. The model estimates as well the percentage of the urban population per country that is highly annoyed due to noise.

These indicators are determined on the basis of the exposure distribution in urban areas in each country: a number of prototypical cases has been mapped in a high level of detail and the distributions found in these cases have been used to estimate the distributions in EU countries.

The inputs for the exposure assessment are data on EU level derived from TREMOVE and Trans-Tools. For each country TREMOVE model provides detailed data on the type of mileage per road (urban, non-urban, motorway), per vehicle type (cars, light duty, heavy duty) and PM10 and NOx emissions per road category and type of area (urban – non urban). Trans-Tools provides data concerning networks (motorways and main roads) and traffic flows (passenger cars and trucks).

The social model

The social 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 framework, which takes as a basis the notion of the Walrasian equilibrium.

The EDIP model is designed to assess the effects of concrete governmental policies. It compares the situation without certain policy measure to the situation with this measure. The model assesses the relative changes in the main variables of the model and the overall welfare resulting from the policy implementation and calculates the effects of the policies over a period of time, which is defined by the model user. It takes as its main inputs the forecast of the future development of the country’s population, labour efficiency, the total factor productivity of the industrial and service sectors, transportation costs by vehicle type and distance class, car ownership costs, emissions factors by type of emissions and world prices by commodity type.

The model includes the representation of the micro-economic behaviour of the following economic agents: several types of households differentiated by 5 income quintiles, 3 degrees of urbanization and 6 family types; production sectors differentiated by 23 NACE classification categories; investment agent; federal government and external trade sector.

The main outputs of the EDIP model are the relative changes in a set of social inequality indicators, including the inequality of income distribution Gini coefficient, the amount of people below the poverty line, the inequality and intensity of poverty.

THE TRANSPORT SUSTAINABILITY INDICATORS

In addition to the classic set of pure transport system operation indicators, the REFIT methodology provides policy makers with a full set of transport "sustainability" indicators, encompassing the economic, environmental and social impact dimensions, which are the specific focus of the REFIT project.

The complete set of indicators, which the REFIT modelling toolbox described above is able to calculate, contains:

- 24 transport system operation indicators;
- 10 transport economic indicators;
- 59 transport environmental indicators including the LoI (Level of Internalisation);
- 9 transport social indicators.

The indicators are computed both for macro-regions aggregations[4] and for countries and allow for the assessment of the effects of transport policies and make comparisons with respect to a baseline scenario.

Transport system operation indicators provide the information concerning: infrastructure consistency, passengers and freight transport performances, vehicle stock size etc. They are computed mainly through the usage of Trans-Tools and TREMOVE models output, and allow assessing the effects of a specific transport policy (change in modal shares, traffic volumes etc.) on the “pure” transport domain; we will not dwell upon these indicators because, as stated above, they are not the focus of the REFIT methodology.

A small selection of the REFIT indicators, per each domain, is shown below.

The economic indicators

The *economic sustainability* of transport policies covers the requirements for strong and durable economic growth, such as preserving financial stability, a low and stable inflationary environment, and capacities to invest and innovate; therefore the basic economic indicators of policy impacts should include changes in e.g. incomes and prices, revenues and expenditures etc. Among the REFIT economic indicators it can be found:

- The *GDP effects induced by transport* policies which is expected to change e.g as a consequence of faster connections provided by new transport infrastructure (TENs).

In fact journey time savings and increased reliability for business travel represent a productivity gain and contribute to GDP. Moreover there are effects in the labour market that may mean further effects of transport on GDP if transport directly or indirectly causes an

[4] The EU27 plus Switzerland and Norway; EUS-12 (new Member States since 2004); EUS-15 (old Member States).

increase in labour supply. In this case GDP rises because time savings have an impact on the labour supply decisions of individuals.

- The *Households and Business transport expenditures*: transport pricing and taxation policies will clearly influence the budget spent by families for transport, while the business expenditures for transport services will be influenced by transport pricing and taxation policies.

- *Government net revenues*: the net amount of funds (taxes – subsidies) raised by the government on transport activities will be directly influenced by any policy change of transport prices and taxes.

The environmental indicators

The *Environmental sustainability* focuses on maintaining the integrity, productivity and resilience of biological and physical systems, and on preserving access to a healthy environment. On the basis of the modelling tools available in REFIT the selection of environmental indicators include as follows:

- *Emissions of pollutants by transport mode*: In REFIT the emissions are computed for CO_2, CO, PM10, NO_x, SO_2 and NMVOC. Transport pricing and taxation measures are usually aimed also to reduce emission of pollutants in congested areas; the same effect is expected from the measures to improve urban transport. R&D activities for cleaner and more efficient transport will improve the technology, and this should contribute to reduce emissions.

- *Population exposure to emissions*: the same measures which help to reduce emissions in densely populated areas are obviously useful to reduce population exposure. In REFIT, it is possible to calculate the population exposure to NO2, PM10 and noise, expressed as percentage of people highly annoyed considering the limits imposed by the EU legislation.

- *Final energy consumption* by transport mode: the most important policies which are expected to influence energy consumption include the rationalisation of urban transport and R&D driven technological improvement.

- *Uptake of cleaner fuels*: the uptake of cleaner fuels may be seed-up by transport pricing and taxation measures, as well as urban transport rationalisation measure, which will make more convenient to use cleaner vehicles and fuels.

- *Internalisation of external costs*: this indicator represents the degree, to which social costs caused by transport activities are carried by the users, and it aims to assess the impacts of policies on the coverage of social costs by the users. It is clearly linked to transport pricing and taxation policies.

The social indicators

The *Social sustainability* emphasises the importance of high employment, of learning skills, of safety nets capable to adapt to major demographic and structural changes, of equity and of democratic participation in decision-making.

The social impacts include the financial effects on income distribution and equity concerns - which would need to be considered alongside the aggregate economic benefits of transport policies – as well as the social impacts in terms of distribution of external costs and benefits, e.g. the effects on people health, city liveability etc..

This dimension is evaluated through the following social indicators:

- *Distributional impacts of transport policies*: transport pricing and taxation policies are expected to have different effects for different income groups. This indicator is expressed through three different indexes : Gini coefficient, GE index - mean logarithmic deviation and

Theil's entropy. Distributional effects is also represented in REFIT by the amount of people that fall below the poverty line.

- *Transport affordability index*: any change of average trip costs due to transport pricing and taxation policies will be directly reflected by this indicator, which could be defined as the transport expenditure made by a household as a percentage of its income.

- *Safety*: the most important policies which should use this indicator to monitor their success are obviously the road safety measures. However, also the realisation of new TEN infrastructures will have an impact on safety, caused by the likely increasing volumes of traffic which should however be at least partially compensated by travelling on safer infrastructures.

THE REFIT OPERATIONAL TOOL

The REFIT operational tool is the instrument where the indicators computed in REFIT are gathered in a coherent way in order to provide the policy makers with a clear overview of the indicators and their individual and total response to a certain transport policy.

The operational tool is represented by Microsoft Excel workbooks containing set of pivot tables and graphs, which allow for a comprehensible analysis of the changes caused by the policy for each sustainability domain.

Due to the high numbers of the indicators that REFIT is able to calculate, synthetic spreadsheets have been set up containing only a small set of selected priority indicator. Such indicators have been chosen as main representatives of the full set of indicators for each domain. Looking at the changes occurred to such indicators with respect to a reference scenario the user can have a quick impression of the policy impact before to explore all indicators in detail.

In the next section some examples of the results obtained applying the REFIT methodology to the transport policies are shown.

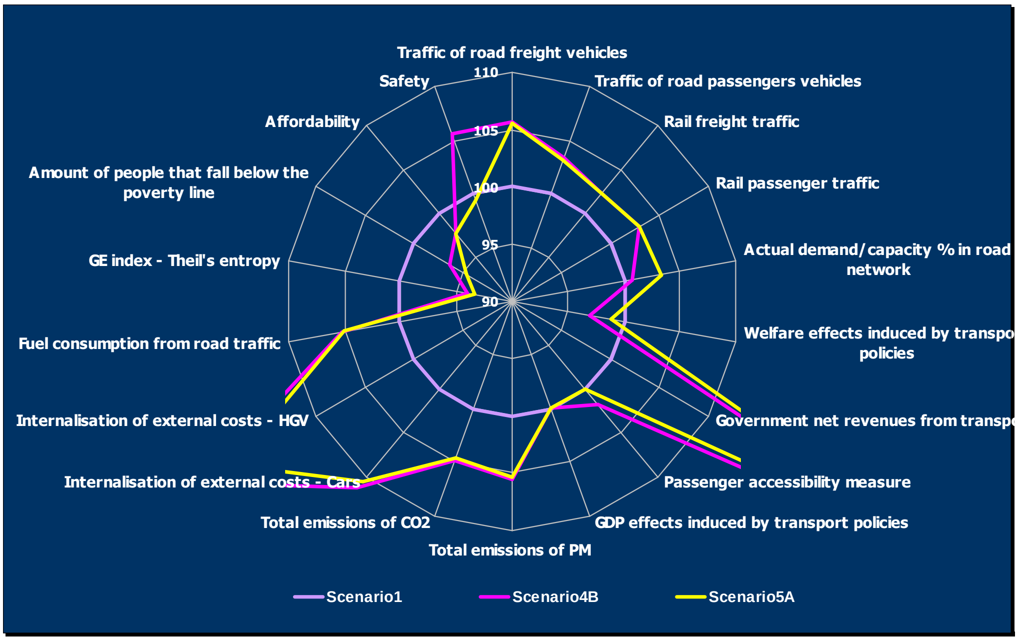
APPLICATION OF THE REFIT FRAMEWORK

The REFIT framework along with the operational tool have been tested by assessing different policies of the internalisation of transport external costs. The objective of the policy here considered was to internalise the five following externalities: climate change, air pollution, noise, accidents and congestion. The means taken into account to achieve an internalisation policy is the introduction of new variable taxes and charges.

Particularly, apart from a reference scenario (Scenario 1 from now on), two variants have been considered in our exercise: the application of the charges on all vehicles (Scenario 4B from now on) or only on HGV vehicles (Scenario 5A from now on). The year of the simulation is the 2020.

As stated above, with the *priority indicators* it is possible to get a quick idea of the overall impact of the policies: the trade-off is visible and the size of the changes in the small set of these indicators allows the user to identify a first broad hierarchy between scenarios. The indicators are reported in a way that higher values correspond to a more sustainable situation starting from the reference case. Consequently, in the figure below, those indicators included in the area edged by the reference case values show a worsening in terms of sustainability comparing to the reference situation.

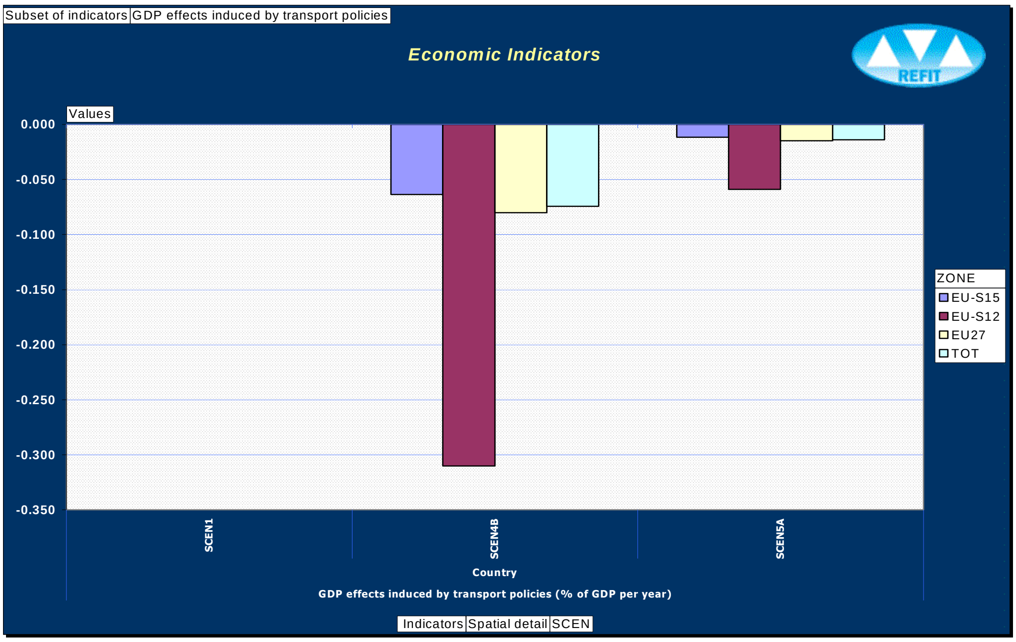
Priority indicators



The results in the specific case tested seem suggesting that Scenarios 4B and 5A are significantly effective in internalising external costs, reducing congestion, emissions and accidents while negative economic and social impacts are not too large when compared to the reference scenario.

Within the *economic domain*, the figure below shows the percentage changes in GDP due to scenario implementation, in comparison with the reference Scenario1. In this case, the results suggest that the chosen pricing scheme in combination with the revenue redistribution proportional to GDP is disadvantageous for the new member states, as they suffer relatively more from increased charging. These negative effects are brought about by the capital outflow.

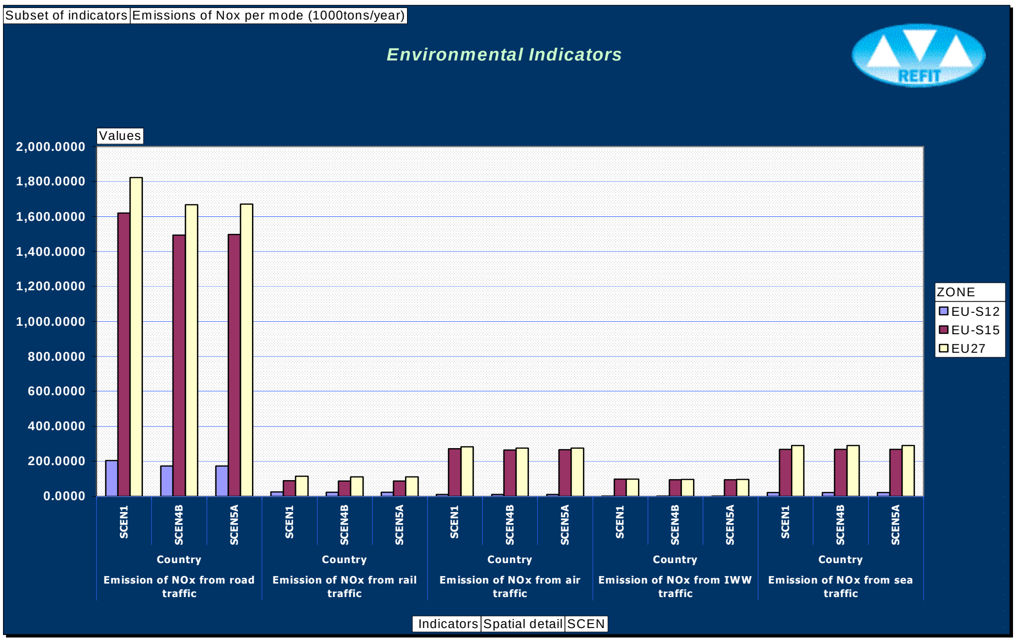
GDP effects induced by transport policies



As mentioned above, the REFIT framework is able to calculate 36 *environmental indicators*.

The NOx emissions, computed for each transport mode, are reported in the figure below.

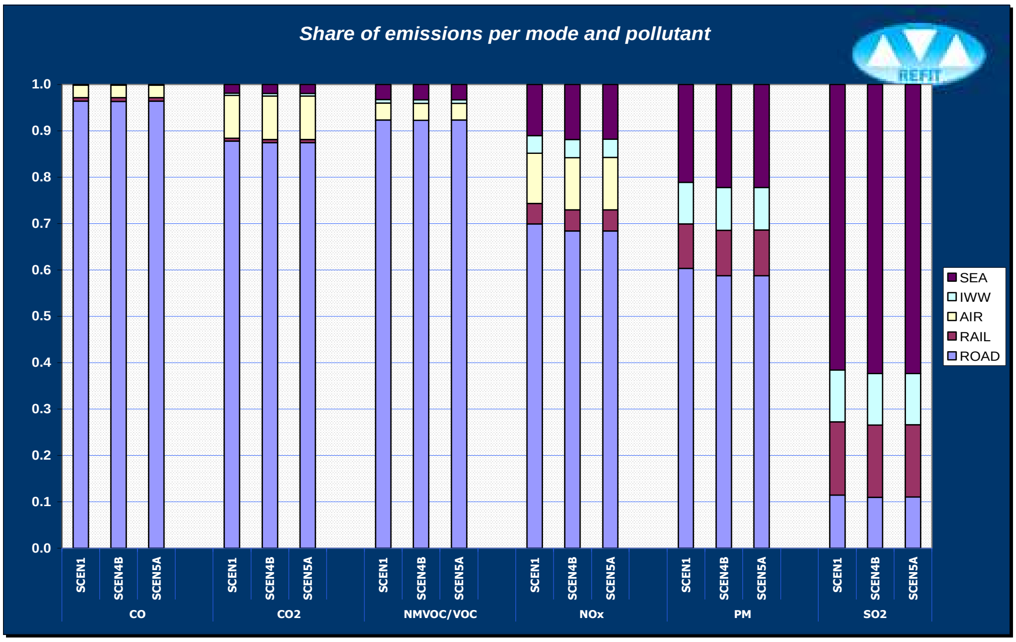
Emissions of NOx per mode (1000 tons/year)



The graph shows that the policy scenarios only moderately affect the emissions, mainly via a decrease of road transport volume caused by the additional taxation. For non-road modes, emissions stay more or less the same.

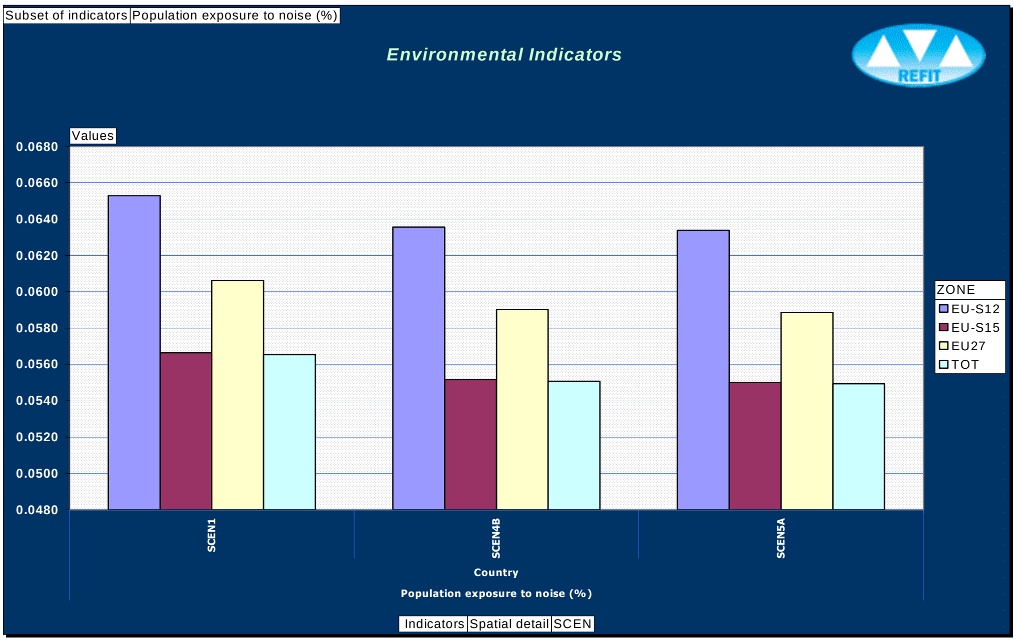
For each scenario, the REFIT operational tool allows for a comparison by mode and types of pollutant. In next graph we see that road transport holds the highest share of total NOx emissions of transport.

Share of emissions per mode and pollutant



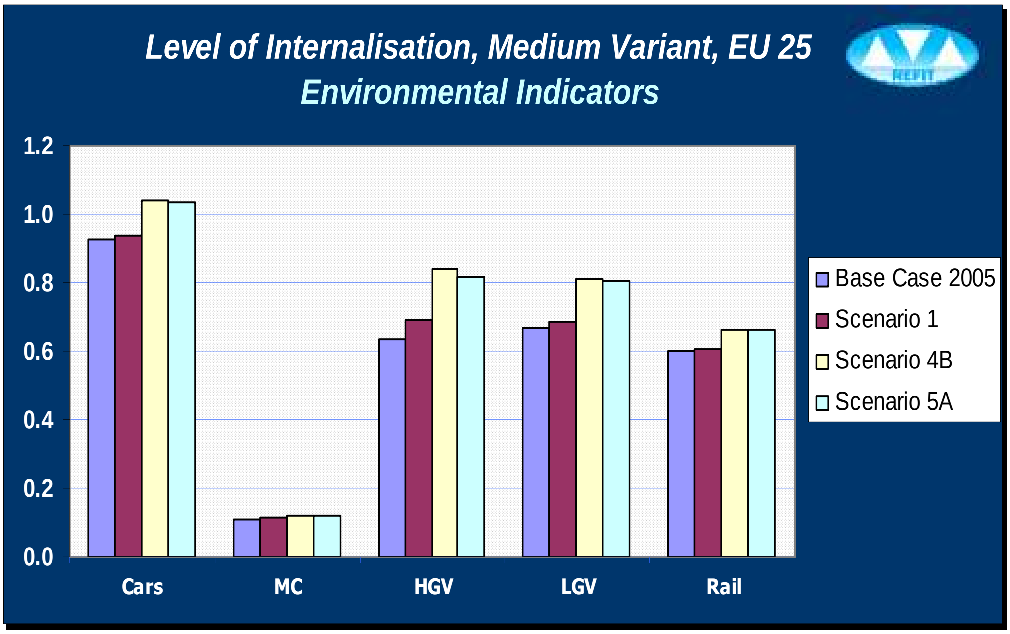
The environmental indicators related to population exposure are computed by the REFIT ad-hoc model. The differences in the scenarios for noise, reported in the graph below, are due to the different vehicle kilometres on the motorways and main roads, calculated by the Trans-Tools model, and the vehicle kilometres on urban roads calculated by TREMOVE. The hierarchy between scenarios is the same as for emissions even if the differences are more subtle.

Percentage of population exposure to noise



Another indicator used in the REFIT framework is the Level of Internalisation (LoI): this indicator represents the degree, to which social costs caused by transport activities are carried by the users. It is computed as the ratio of private costs for a specific transport user and the social costs generated by this activity, using the basic cost elements of the relevant transport mode. The following graph shows the results for this indicator where different scenarios are compared by mode.

Scenarios for the LoI in 25 European countries



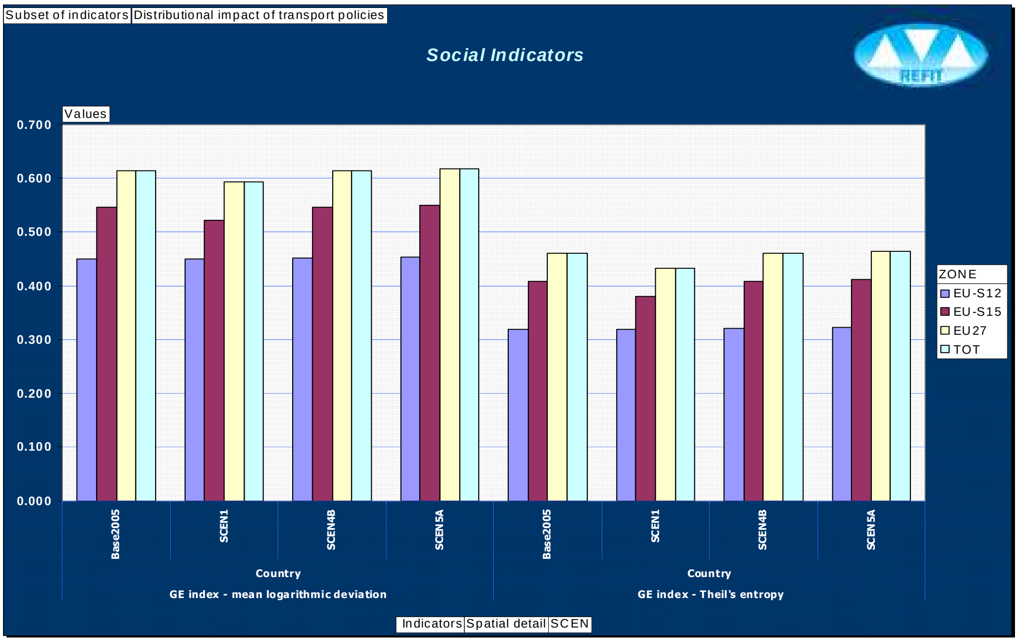
The LoI increases significantly in the pricing Scenarios: 4B and 5A reach a LoI above one, which implies that social costs are lower than private cost, i.e. more is paid by the users than their costs they cause.

While cars have a high level of internalisation, motorcycles show much smaller values and additionally, the scenarios have no significant impact on the LoI. This implies, that (i) a huge gap exists between private and social costs and (ii) that the envisaged policies of the scenarios have practically no impact with regard to cost-coverage.

The aim of the scenarios analysed in our study, is the internalisation of external costs through different policy measures. Therefore transportation taxes are changed in order to better represent its real cost to the society. In general increase in the overall amount of taxes paid by the individuals decreases their disposable income and this leads to negative welfare changes in the neoclassical approach. Social indicators address a different issue: in order for the income inequality and poverty indicators to show significant changes, the implemented policy measures should have a strong impact upon the welfare and income of two lower income quintiles. This is not the case for the scenarios we have tested since the taxes are significantly increased only for the private transportation.

Three different indicators are computed as each one has a different sensitivity. The Gini index gives a very good overall measure of inequality, while Theil's index gives a lot of information on changes around the middle of the distribution and the mean logarithmic deviation gives more information on changes in the lowest income quintiles. However, there are no differences in the direction of change between the different inequality indicators.

Inequality indicators: Mean Logarithmic deviation and Theil's entropy.



On the European level, inequality increases slightly, as expected. There is no big difference between changes in the index for the EUS-12 (new Member States) and EUS-15 (old Member States) or between the mean logarithmic deviation and Theil's entropy.

A different social indicator deals with safety. The safety indicator shows if the analyzed policy measure has an effect on traffic safety in the EU countries. This indicator is measured by counting the number of fatalities: traffic safety increases when this number of fatalities decreases. The number of fatalities is directly related to the number of vehicle kilometers driven by road transport.

CONCLUSION

The application of the REFIT framework for the assessment of the effects of the transport policies provides a complete set of indicators covering all the sustainability domains and allows the user to analyse the policies impacts in a multidimensional manner and identify advantages and disadvantages of the measures simulated.

The test performed proved the indicators are exhaustive to provide a wide overview on the effects of the internalisation of external costs policies: the indicators behave largely in accordance to theoretical expectations; despite the similarities of the tested scenarios, which concerned different details in the implementation of the same measure (transport charging), the REFIT indicators proved able to discriminate between the different scenarios.

Even if such scenarios deal with transport pricing and therefore economic and transport indicators may be the first ones capturing user’s attention, environmental and social impacts enrich the description of policy effects and add information for a fair judgement of the measures simulated.

Looking at the indicators, the user can find a confirmation that levying taxes and charges brings about an increase of travel costs, but can appreciate the impact of such increase on the traffic performance as well as on the regional economic activity.

The average costs of transport trips is increased to correspond to the level of the external costs associated with transportation: increase in transport tax burden decreases demand for transport, which is reflected in reducing congestion, emissions and accidents, but it also increase the expenditures of both firms and households. The social indicators reflect the effect of increases in taxation, while the effect is probably limited for the poor population due to their lower consumption of transport services, and small increases in inequality and in poverty can be noted. However, these effects are not as important as the economic effects on the transport sector and differ between countries.

Since a trade-off exists among the different dimensions of sustainability, the best alternative scenario does not become apparent from indicators. And the selection of the ‘most preferable one’ is not part of the objectives of REFIT; instead, the assessment framework offers several detailed data that can be used for further analysis.