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ASSESSMENT AND FURTHER DEVELOPMENT OF THE TREMOVE MODEL

Inception Report

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1. INTRODUCTION

The TREMOVE model is an integrated simulation tool developed for strategic analysis of costs and effects of a wide range of policy instruments applicable to local, regional and European transport markets. The model was developed to support the policy assessment process within the framework of the Auto-Oil II Programme and incorporates components of various models developed at European scale (TRENEN, EUCARS, FOREMOVE), the European Environmental Agency COPERT-II methodology and the EPEFE equations, to account for changes in the average fuel quality over time.

The TREMOVE model is used to compute the effects of various types of policy measures on the key drivers of transport emissions. It belongs to the family of the integrated models, as it is composed of three inter-linked main simulation blocks - transport demand, vehicle stock and transport emissions.

In evaluating the opportunity of investing in further development of the TREMOVE model, the Commission wants to consider the features of the model itself as well as the results of the several R&D activities and models which have produced simulations of the impacts of transport policies on the environment after the completion of the second European Auto-Oil Programme (AOP II).

This inception report outlines the activities that will be carried out in order to come up with an assessment of the TREMOVE model. Firstly, in the next section 2 the main questions which should be answered at the beginning of the work are listed. In section 3, the main issues to be dealt with are presented and discussed. Finally, the sequence of planned tasks is introduced in section 4.

2. A LIST OF PRELIMINARY QUESTIONS

In the following sections the content of the work of assessment of the TREMOVE model is explained as well as the various steps we are going to follow. Though the framework used in the pages below has a general value, a more precise definition of the nature and of the limits of the activities requires the clarification of a list of open issues. These are presented in the text and are summarised here for sake of convenience.

- What should be the future use of TREMOVE by the Commission services?

- What types of policies will have to be simulated with TREMOVE?

- Which types of policy impact is TREMOVE requested to simulate? Is there the interest to go for a wider range of policy impacts (externalities, economic costs, etc.)?

- Which are the main desirable features of the enhanced TREMOVE model?

- Which type of connection with a transport model is envisaged for TREMOVE? Will it be a full integration (the transport module is fully integrated in the TREMOVE framework) or a loose connection (TREMOVE and the connected transport model(s) are run separately and exchange inputs and outputs)?

- Which are the relevant transport/energy/environmental projects and models in connection with TREMOVE? And which are the expected links that might have to be considered?

- How much the user-friendliness and the portability of the model are important for the Commission services, taking into account that this might have a trade-off with model design and capabilities?

The rationale behind such questions is explained in the text. Commission services (DG TREN, DG TAXUD, DG ENV, EG ECFIN, DG ENTRE) and other European institutions involved in this project are kindly requested to give their fundamental support in this starting phase.

3. ASSESSMENT OF THE TREMOVE MODEL: MAIN ISSUES

In this section the main aspects concerned with the technical assessment of the TREMOVE model are discussed. Such aspects can be divided into four broad areas:

- the definition of the expected use of TREMOVE in the future;
- the current and the desirable features of TREMOVE;
- the possible link between TREMOVE and transport models;
- the position of TREMOVE with respects to other existing projects and models focused on transport and environment.

3.1 The future use of TREMOVE

TREMOVE is an instrument built in the course of the Auto-Oil II Programme. The use of the model within this project was a major element in its development. The focus was on its capability of dealing with the relevant issues for the Auto-Oil study.

The aim of the project is an assessment of TREMOVE and of its abilities to handle critical options and issues in strategic EU programmes for environment, transport and energy. In such a task, the expected use of the model in the future is a primary element to be taken into account. The range of policies affecting transport emissions is wide: some of such policies can be well represented within the current framework of TREMOVE, others can not.

The TREMOVE authors explicitly stated that it "is a simulation model and not a transport-forecasting model"[1] and it is then important to understand whether this is still the orientation of the Commission services in the further development of the model.

In brief, the assessment of TREMOVE cannot avoid exploring first which are the plans about the use of such a tool. The Commission services and, *in primis*, DG ENV, DG TREN and DG ECFIN are then requested to clarify this point.

3.2 Current and desirable features of TREMOVE

A direct consequence of the plans about the use of TREMOVE is the identification, among the current features of the model, of those elements that might be enhanced and those that might be added to its structure. The definition of an ideal, though realistic, enhanced version of TREMOVE would be the outcome of this process.

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[1] Auto-Oil II Cost-effectiveness Study – Part II: The TREMOVE model - Introduction

A list of the desirable improvements will be produced as a result of the analysis and on the basis of the previous point, nevertheless a preliminary (and probably incomplete) list can be quoted in advance:

- extending the coverage of transport modes, adding sea shipping, air transport and inland navigation;

- extending the coverage of pollutants, adding new ones (HFCs, CH_4, N_2O, Ozone concentration and any other element which is reputed as relevant);

- extending the geographical scope, including non-EU countries like Norway and Switzerland and eastern Europe countries;

- improving the representation of trip categories (e.g. passenger trip purposes, freight commodity types) and of transport behaviour (modal choice, network congestion, etc.);

- improving the representation of long-distance road traffic;

- improving the user-friendliness of the model interface.

3.3 Linking TREMOVE to transport models

The representation of traffic in TREMOVE is simplified and the framework used is strictly bound to the spatial domains considered: sample cities, other urban areas, non urban areas. Ideally, the link with network-based transport models could provide a better simulation of transport flows, with the chance of taking into account local elements, as well as a more sophisticated response of transport choices to relevant policies. Of particular relevance is the need of a good representation of local traffic, which is one main source of emissions. As this issue concerns also many network-based models at the larger scale, it requires some thoughts.

With reference to the modelled countries, TREMOVE currently uses external data collected from a variety of sources at national level, including public organisations, transport authorities, transport ministries, private consultants. The objective of a link with a transport model is then threefold:

- to ensure consistency among the different modelled countries and the different levels: long-distance traffic, local traffic, etc.

- to ensure consistency with transport/traffic forecasts drawn from other European scale models and consequently, their impacts on energy consumption and emissions;

- to allow for analysing the impacts of transport investment and policies in terms of variations in the use of transport networks and therefore in specific geographic contexts.

Trade off between the degree of complexity of the models to be interfaced and the degree of integration of different modules will be a central subject in the analysis as well as implications in terms of such models to be used by Commission' policy analysts. In principle, two different strategies are to be compared:

- transport model/s and TREMOVE are run separately exchanging outputs and inputs (i.e. they are *connected* but not *combined*);

- transport model/s and TREMOVE are two components of an integrated modelling platform.

An instance of the first alternative is provided by the experience of the Strategic Environmental Assessment (SEA) pilot study, where the integration of the network based STREAMS transport model with emissions calculation models was successfully carried out[2]. In this project, the transport emissions were based on the traffic loads calculated for the European multimodal network of the STREAMS model. Such loads fed the MEET/COMMUTE model to calculate the correspondent emissions.

An example of the second alternative is the ASTRA System Dynamics platform which was calibrated to demonstrate the feasibility of an integrated model able to simulate long term impacts of transport policies and investment on the environment, and also macroeconomic and regional economic systems at EU scale[3]. In this case, the transport emissions considered by the ASTRA platform were derived from aggregated traffic loads calculated by its integrated transport module.

The first alternative might be a more flexible one, especially in order to explore the chance of linking TREMOVE to existing models a different scale. The second alternative might integrate a transport module adaptable to different contexts and scale and using existing models as benchmark. In both cases, the need of exchange information requires standard definitions of the basic components of the models (flows, capacity, vehicles and so on). The work carried out to define a GTF (Generalised Transportation-data Format)[4] for data exchange between transport model, databases and GIS systems could be helpful in this issue.

This means also that the trade-off of a close and a loose interaction will be considered, where a close interaction probably means a less detailed transport model

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[2] "Forecast of EU/TEN-T transport and emissions: a pilot study", ME&P, TRT, COMMUTE consortium, MEET consortium and SCENARIO consortium, Final report, March 2000.

[3] "ASTRA Methodology", IWW, TRT, ME&P and CEBR, Final report, December 2000.

[4] The analysis of the GTF conceptual model is one out of the four research areas of the Spotlights TN managed by DG TREN in the course of the Fifth Framework Research Programme in order to bring light on advanced transport models.

and a loose interaction would lead to the use of a more sophisticated transport model. For the integrated approach it would be important to analyse the model "portability", which means that the model could be run directly by policy makers in the Commissions offices. For the separated approach it will be relevant to consider the automation level of the connection between the models, taking also into account the possibility of using internet.

3.3.1 National transport models

A number of national transport models exist in European countries. The chance to link TREMOVE to such models, in order to perform more detailed analysis, might be of interest even though it certainly has a lot of difficulties. The task is complicated by the fact that each model is different in terms of scope, detail, spatial detail, transport mode coverage, etc. Furthermore it must be stressed that not all these national transport models are fully operational (in other words, results are not always available).

As reported by A. Daly[5], national transport models have been built in England (Regional Highways Traffic Model – RHTM for road passenger traffic), The Netherlands (Netherlands National Model – NNM), Norway, Italy, Denmark, Sweden[6].

3.3.2 Modelling metropolitan and urban areas

Appropriate simulation of urban and local traffic is a critical problem for strategic transport forecast at European scale: its relevance is due to the fact that the volume of such traffic is definitely predominant and also for its interaction with long–distance traffic. Many road bottlenecks are located around metropolitan areas, where through traffic compete for capacity with local flows, and this is dramatically true for rail transport as well.

For each modelled country, the current design of the TREMOVE model is able to distinguish transport and emissions in three domains: sample cities[7], other urban areas and non-urban areas. It seems then relevant to consider the possibility to improve the TREMOVE modelling approach to simulate the impact of transport policies on the urban environment of a wider range of cities, including those of average size.

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[5] "National Models" in "Handbook of Transport Modelling, edited by D.A. Hensher and K.J. Button, Pergamon, Elsevier Science, 2000.

[6] Comparable models also exist in France, Hungary, Belgium, Austria and Switzerland.

[7] Also called AOPII-cities: Athens, Berlin, Cologne, Dublin, Helsinki, Utrecht, London, Lyon, Madrid and Milan.

A wider classification of urban typologies might certainly enhance the capability of the TREMOVE model to simulate the transport behaviour in urban areas be. A solution successfully explored in ASTRA[8], and also in SCENES, was to classify regions making reference to settlement types, distinguishing between different "functional" areas (from big metropolitan areas to rural regions) and to distance bands with similar transport behaviours: in a given urban area the modal split for the very short trips (1-2 km) includes slow modes and is totally different from the one for longer trips (i.e. 8 km), where metro or bus (according to the urban functional typology) can be competitive.

In addition, a more explicit representation of traffic between the different areas would be useful to examine the effect of policies on the distribution of trips.

3.4 The positioning of TREMOVE in the context of other models

Another relevant part of the work is analysing of the position of TREMOVE in the family of relevant models developed/improved in EU programmes. A number of projects relating to environment, energy, emissions have been completed or are being undertaken. Other models have been developed which analyse transport emissions. Some models provide the same type of results of TREMOVE as their main outcome (e.g. STEEDS[9]). Others provide data on transport emissions among other results (e.g. PRIMES[10]). Others deal with specific aspects which TREMOVE address to as well (e.g. the fleet model developed by COWI[11]).

The analysis of the comparison of the results provided by TREMOVE and the other models and the understanding of the reasons behind such results (differences in scope of the models, in detail level, in assumptions, etc.) will be useful elements to verify the TREMOVE model design.

The STEEDS model

The STEEDS research was funded in part by the European Commission in the framework of the Non Nuclear Energy Programme JOULE III. The project developed a Strategic Transport-Energy-Environment Decision Support to assist

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[8] The ASTRA model makes reference to notional representation of space which builds on a clustering with 6 *functional zones* based on the settlement patterns of the EU 201 NUTS II zones

[9] "Scenario-based framework for modelling transport technology deployment: energy-environment decision support (STEEDS) – Final Report", AEA Technology plc, UK, October 1999.

[10] "The PRIMES Energy System Model – Reference Manual", National Technical University of Athens, 1998

[11] "Study on the potential effects of fiscal framework measures to reduce CO_2 emissions of new passenger cars" - Annex A, The Passenger Car Model", COWI.

users in exploring options for influencing the choice and use of different vehicles for environmental benefits. The STEEDS system has two major components:

- a sequence of simulation models (or *modelling chain*) which provides projections of transport supply and demand, and calculates the corresponding energy use, emissions and environmental impacts;

- a module which supports *decision-making* on the integrated set of simulation results, and provides user-friendly access to detailed data.

The scope of STEEDS covers passenger and freight transport, across all transport modes. The system provides annual projections from 1995 to 2030 of national-level results, with disaggregation by route type (urban, rural, motorway, etc.), for all EU Member States.

The PRIMES model

The development of the PRIMES energy system model has been supported by a series of research programmes of the European Commission. PRIMES is a modelling system that simulates a market equilibrium solution for energy supply and demand in the EU member states. It is conceived for forecasting, scenario construction and policy impact analysis, covering a medium to long-term horizon. Demand is evaluated at a national level in different sectors: residential, commercial, industry, transport.

The transport sector distinguishes passenger transport and goods transport as separate sectors. They are further subdivided in sub-sectors according to the transport mode (road, air, etc.). At the level of the sub-sectors, the model structure defines several technology types (car technology types, for example), which correspond to the level of energy use.

The overall demand for transport (passenger per km, tonnes per km) is determined by income/activity growth and by the overall price of transport. The overall price of transport is determined endogenously, as a function of the modal split and of the price per mode. The split of the overall transport activity over the different modes is driven by the price per mode and by behavioural parameters.

Other models

Other models that are, in principle, of interest with respect to the assessment of TREMOVE are:

- RAINS;

- COPERTIII - ARTEMIS - TRENDS;

- STAIRRS;

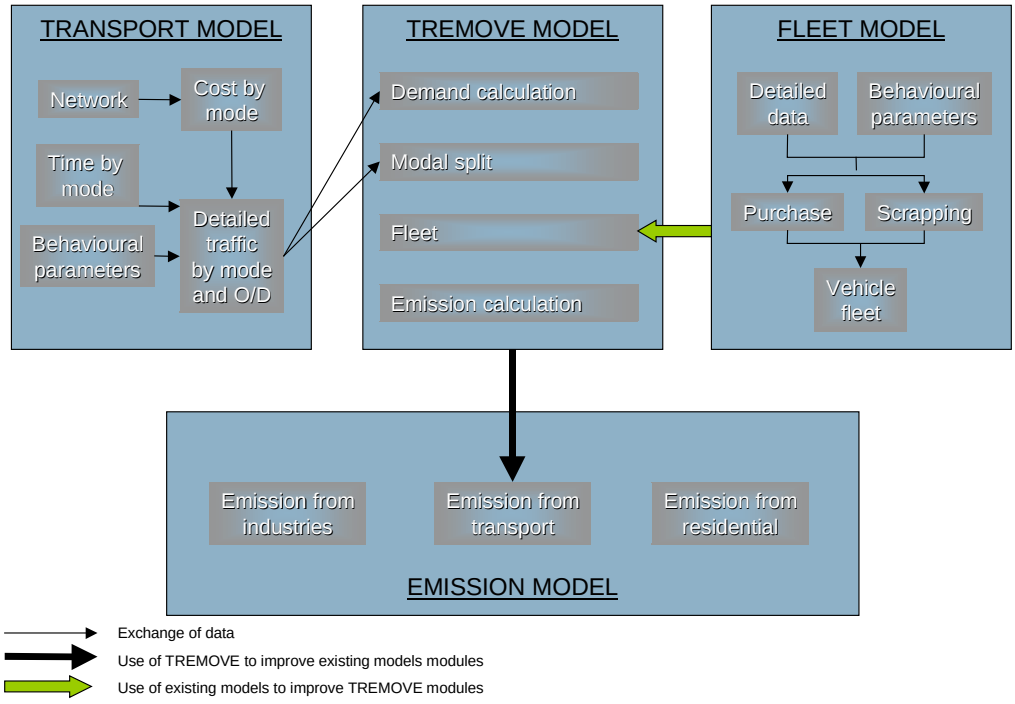
- CAFE programme;

- etc.

It is quite clear that a correct assessment of TREMOVE position with respect to other models require a careful analysis of the features of such models. The support of the Commission to identify such projects and the suitable contacts and to collect the relevant material might be required.

Figure 3.1 provides an example of possible different links among TREMOVE and other models (including transport models).

Fig. 3.1 Possible links between TREMOVE and other hypothetical models



4. PROJECT TASKS

The project activities will be focused on the issues described above and will be organised in the main steps.

Task 1 Review of the TREMOVE model structure and database

The work will rely on existing documentation, direct experience of the consultant in related projects and discussions with experts involved in the development of TREMOVE and is split into four main sub-tasks.

1.1 Analysis of model design

1.2 Analysis of the data structure

1.3 Linking to transport models

1.4 Positioning with respect of other transport/energy/environmental models

Task 1.1 Analysis of model design

Model design analysis will consist in a thorough examination of model characteristics and capabilities. Particular attention will be given to:

a) *model framework design*, which means to investigate the model components and their interrelations, the examination of the key model variables and their capability to simulate different policies, the verification of the exogenous variables (i.e. those data that are taken from outside the model) and the assessment of the framework extendibility to include more detailed simulation of relevant model components;

b) *model technical performance*: this consists of a check of the validation data set of the model for the year 2000 to ensure that relevant variables are reproduced by TREMOVE within a reasonable confidence range; the activity will also include the examination of the model strengths and weaknesses and the results of the sensitivity analysis for a given number of key variables; eventually this activity will also include the review of the calibration parameters (elasticities, preferences, etc.) examining the possibility to modify them on the basis of available scientific data; a further element in this analysis will be the comparison between TREMOVE and other model results[12].

c) feasibility of a *user friendly interface* to run the model setting up scenarios and examining the corresponding results, on the basis of the fact that the current version of TREMOVE cannot be run directly by the final users but need a careful and time consuming implementation phase by the modellers themselves; care will be devoted to explore the different development possibilities: to provide a - maybe internet based - channel of communication between the users and the modellers (as suggested by the TREMOVE authors in their recommendations[13]) or to built a proper interface on stand alone models where the user is allowed to directly play with a (limited) set of scenario variables and to browse the model results;

d) *software code optimisation*, which will be deeply examined with reference to the model running time; this point is strictly linked to the previous one as an user friendly interface can be efficient only if the model guarantees reasonable running times.

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[12] In Appendix 4 of "Economic Evaluation of Emissions Reductions in the Transport Sector of the EU – Bottom-up Analysis – Final Report" (AEA Technology Environment and National Technical University of Athens, March 2001) a comparison between TREMOVE and PRIMES is reported: a number of differences are registered, ranging from different values of traffic to different treatment of average loads (fixed in PRIMES, variable in TREMOVE).

[13] Auto-Oil II Cost-effectiveness Study – Part II: The TREMOVE model - Annex C.

Task 1.2 Analysis of the data structure

The *analysis of the data structure* will be aimed at assessing the quality and the level of detail of the model database also from the point of view of its extension to new countries. The planned activities will include a thorough analysis of the following points:

a) *level of detail of the database* and its capability to represent, in a appropriate manner, the differences among the EU member states: here the problem is to verify how realistically close is the model database level of detail to the optimum threshold, i.e. when data are enough aggregated to be collected relying on official sources and at the same time are broken-down enough to grasp the specific characteristics of each country;

b) *data requirements* for the extension of TREMOVE to the 15 countries of the EU, the accession countries, Norway and Switzerland, considering the variety of data quality and availability among these countries (the possibility to make reference to two different data sets – EU members, Switzerland and Norway vs. accession countries – will also be carefully studied);

c) possibility to update the model database using *official sources*, such as EUROSTAT, in order to minimise the efforts to keep the TREMOVE model up to date and, on the other hand, the possibility to produce results in a format to be smoothly transferred to the Commission services and other institutions (again EUROSTAT);

Task 1.3 Linking to transport models

This tasks includes three main activities:

a) a *review of the EU-wide transport models*, making reference to the IV and V Framework Research Programme for Transport as well as to other relevant EU-wide projects. The guideline for such an inventory will take into account the zoning detail, the transport modes coverage, the running times, the software basis, etc.; this task will benefit of the work carried out in the Spotlights TN, where a European transport models directory (MDir) has been set up[14].

b) analysis of the *representativeness of the city classification* adopted in TREMOVE. The possibility to modify the current three level simulation scheme (cities, other urban, non urban) will be analysed; in particular the attention will be paid to the opportunity to increase the typologies of cities and to define sample cities also for all levels groups;

c) the choice between a *close interaction* - the inclusion of a transport module within the TREMOVE framework - and a *loose interaction* - the connection of TREMOVE with external transport model(s) and the definition of the data to be exchanged.

[14] MDir is one of the four discussion lines of Spotlights TN: data are available at the project web-site: http://www.mcrit.com/SPOTLIGHTS/index.htm

Task 1.4 Positioning with respect of other transport/energy/environmental models

The analysis of the links between TREMOVE and other transport/energy/environmental models will be aimed to identify the chance of taking advantage either from the exchange of information or from transferring modelling solutions from one model to another. The following steps will form the analysis:

- a description of the points of contact between TREMOVE and the other models, in terms of methodology, scope, results;

- a description of the possible use of TREMOVE in conjunction to/in addition to other models or single modules of other models.

Task 2 Recommendations for the TREMOVE model development

This part of the analysis will build up on the “Needs of the Commission services for a modelling tool in transport” (annex 2 of the Terms of Reference), on the "Recommendations for future work” (Auto-Oil II Cost-effectiveness Study – Part II the TREMOVE model - Annex C) and on the analysis carried out in Task 1.

Commission and EU strategies for sustainable transport and energy consumption will be preliminary screened to understand the extent up to which associated impacts/cause effects mechanisms/critical problems should and could be handled in TREMOVE.

Starting from specifications for relevant policies/issues and from the outcome of different analysis carried out in Task 1, the proposed enhancements to the TREMOVE structure will be defined and described.

The role of each TREMOVE component will be assessed in order to define:

a) data requirements,

b) need for further development of the design or, alternatively,

c) need for a radical revision of the design.

In addition to the above, similar specifications will be given for the new components to be added to TREMOVE, as for example the transport component.

Task 3 Preparation of the action plan

The last phase of the project summarises activities carried out in tasks 1 and 2 and consists of the definition of the operating plan. It is divided in four steps:

a) *"stop or go" recommendation*: this is to state if it is worth and at which conditions to further invest on the TREMOVE model so that it can continue to be a reference model for the Commission services when carrying out environmental or economic analysis of transport policies; in the assumption of a positive response to the point above, the following step is the:

b) *cost-effectiveness analysis* of possible alternative solutions to proceed in the development of TREMOVE; the alternative solutions defined on a technical basis will be assessed considering implementation costs, times and detail and quality of expected results;

c) *definition of terms of reference* for the model development activity and its maintenance taking into account the capability of the technical staff of the Commission to actually implement such a plan;

d) *definition of a preliminary budget* and advise on how to manage the TREMOVE development among stakeholders and within the Commission, considering the possibility to further develop forms of co-operation among the Directorates, along the line of the ad hoc steering group which will be set up for this project.