

GLOBAL SCALE SYSTEM DYNAMIC SIMULATION MODEL FOR TRANSPORT EMISSIONS (GLADYSTE): TRANSPOSING THE STRUCTURE OF THE REMOVE MODEL INTO A SYSTEM DYNAMICS CODING

CLIENT: *European Commission – Directorate General Joint Research Centre (Institute for Prospective Technological Studies)*

YEAR: *2008 – ongoing*

DESCRIPTION OF ACTIVITIES

The core objective of the GLADYSTE research and development project is to generate a Vensim© version of the REMOVE template, able to accommodate a global transportation model. More than a mere translation of REMOVE in the System Dynamics platform, the aim of the GLADYSTE project is to add some more relevant concepts in comparison to the current REMOVE model, such as the ability to endogenously generate transport demand.

The final product expected from the project is a model prototype able to address with an appropriate degree of detail issues like:

- Policies related to vehicle technologies: accelerated vehicle fleet renewal, etc.
- Policies related to the fuel quality: regulatory aspects of fuel quality in terms of costs and the environmental benefits obtained.
- Policies related to fiscal instruments in the transportation sector: freight taxation, vehicle taxation, incentives for low emission cars, internalization of external costs via Pigouvian taxes, etc.
- Policies related to traffic management (logistics in passenger and freight transport, induction of changes in the speed-flow curves, etc).
- Policies related to maritime and air transport, where modal substitution is more limited and the international traffics are relatively more important.

The model prototype will also allow the linkage with the POLES energy model, in order to serve it with the required transport inputs replacing the existing POLES transport sub-modules.

Project activities

The project is split in four main activities:

- The reviewing activities,
- The conceptual elaboration of the model prototype,
- The model implementation,

- The assessment of calibration procedures and the estimation of a preliminary baseline.

The reviewing activities concern in principle both models involved in the project, i.e. the existing REMOVE model and the POLES transportation modules, and are focused on the analysis of the structure of the models in order to select, improve and integrate those parts which are relevant for building the new model prototype.

Based on the reviewing activities, the conceptual elaboration of the prototype is developed, also allowing the preparation of a detailed plan for the recoding activities requested for the model implementation. Then, the building activity will start according to the conceptual elaboration developed during the previous phase. Finally, the calibration of the model in comparison to main data sources and forecasts will be assessed and a preliminary business-as-usual scenario will be simulated.

The GLADYSTE prototype structure

Like the original REMOVE structure, the prototype model is made of four main modules:

- The transport demand module,
- The vehicle fleet module,
- The environmental module,
- The welfare module.

The four modules are linked together, i.e. they exchange information in order to provide a consistent picture of the different aspects modelled. The following figure shows the main relationships between the modules. Within the DEMAND module, motorised transport demand is endogenously generated and segmented according to several dimensions (e.g. national/international, long or short distance, etc.). In addition, the choice of mode and road type for each specific context is carried out taking account demand supply interaction. Transport demand by mode is then the input for calculating vehicle-km by type and technology according to the fleet structure estimated in the

FLEET module. In the ENVIRONMENTAL module, fuel consumption and emissions are calculated on the basis of vehicle-km (from the FLEET module) as well as average speed of each transport mode (from the DEMAND module).

Finally, the WELFARE module takes its input from both the transport module and the environmental module in terms of consumer utility and, respectively, external costs.

The linkages between modules give rise to some loops (feedback effects) in the model, which can be treated accurately thanks to the System Dynamics structure of the model prototype.

Not surprisingly, there are many similarities between the current REMOVE model and the GLADYSTE prototype. However, in the prototype, there are also some significant changes with respect to the current REMOVE. Such changes are extensions of either the scope of the model or of its functions. The main changes are:

- The prototype is a global model rather than a European model;

- Demand is endogenously generated instead of using an exogenous demand baseline;
- The prototype is a dynamic model and therefore the impact of changes in one year has effect also on the following periods, while in the current REMOVE each year of simulation is basically independent;
- Fleet module is improved (e.g. innovative technologies like electric cars or fuel cells are included in the car fleet, scrappage is explicitly modelled);
- The linkages between the modules are extended, thus improving the internal consistency of the model;
- Different market shares algorithms are used.

TRT role

Within the consortium, TRT involvement is particularly related to the development of the endogenous transport demand module of the prototype, as well as a support for the translation and modularization activities in Vensim© thanks to the experience gained with the development of the ASTRA model.

Modular structure of the prototype and linkages between modules

