Ref. Ares(2020)5814965 - 23/10/2020

Commission modelling inventory and knowledge management system (MIDAS)
Report generation date 20/10/2020

MIDAS includes the descriptions of models in use by the Commission in support to the policy cycle. MIDAS is developed and managed by the **Competence Centre on Modelling** of the European Commission.

Find out more at https://ec.europa.eu/knowledge4policy/modelling_en
Contact: EU-MIDAS@ec.europa.eu

Factsheet

SWD/2017/0650 final

Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council: setting emission performance standards for new passenger cars and for new light commercial vehicles as part of the Union's integrated approach to reduce CO2 emissions from light-duty vehicles and amending Regulation (EC) No 715/2007 (recast)

Supporting model(s)

CO2MPAS, DIONE, E3ME, GEM-E3, PRIMES-TREMOVE

Impact assessment
SWD/2017/0650 final

Fact sheet on model contributions

Source: Commission modelling inventory and knowledge management system (MIDAS)

Date of Report Generation: 20/10/2020

© European Union, 2020
The Commission's reuse policy is implemented by the Commission Decision of 12 December 2011 on the reuse of Commission documents. Unless otherwise indicated (e.g. in individual copyright notices), content owned by the EU on this website is licensed under the Creative Commons Attribution 4.0 International (CC BY 4.0) licence. This means that reuse is allowed, provided appropriate credit is given and changes are indicated. You may be required to clear additional rights if a specific content depicts identifiable private individuals or includes third-party works. To use or reproduce content that is not owned by the EU, you may need to seek permission directly from the rightholders. Software or documents covered by industrial property rights, such as patents, trade marks, registered designs, logos and names, are excluded from the Commission's reuse policy and are not licensed to you.

Disclaimer: The Commission accepts no responsibility or liability whatsoever with regard to any and all information made available on or accessible through MIDAS website. The information, including but not limited to models, impact assessments, models' input and output data, and metadata, modelling exercises and policy contributions, is of a general nature only and is not intended to address the specific circumstances of any particular individual or entity, and may not be regarded as comprehensive, complete, accurate or up-to-date. The Commission furthermore does not assume any responsibility for content of any external websites to which links maybe provided on this website. Any and all information provided may not be regarded as professional or legal advice. Information available through the website may not be referenced as officially adopted text of European Union regulatory or policy documents or sources. Their authentic versions can only be accessed through the Official Journal of the European Union (the printed edition or, since 1 July 2013, the electronic edition on the EUR-Lex website).

Overview

Title
Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council: setting emission performance standards for new passenger cars and for new light commercial vehicles as part of the Union's integrated approach to reduce CO2 emissions from light-duty vehicles and amending Regulation (EC) No 715/2007 (recast)

Document ID
SWD/2017/0650 final

Year of publication
2017

Led by
CLIMA

Model(s) used
CO2MPAS, DIONE, E3ME, GEM-E3, PRIMES-TREMOVE

Additional information on model use for this Impact assessment

The Baseline scenario used in this impact assessment builds on the *EU reference scenario 2016 Energy, transport and GHG emissions : trends to 2050, Luxembourg: Publications Office of the European Union, 2016, doi:10.2833/9127,* (in particular for GEM-E3, PRIMES, PRIMES-TREMOVE), but additionally includes few policy measures adopted after its cut-off date (end of 2014) and some updates in the technology costs assumptions. For details, please check the text of the impact assessment report.

CO2MPAS

Full title

CO2 Model for PAssenger and commercial vehicles Simulation

Run for this impact assessment by

European Commission

Contributed to

Baseline only

Details of the contribution

Co2mpas was used to calculate the baseline 2015 CO2 emissions from the European fleet of new passenger cars under WLTP conditions.

DIONE

Full title

Road Transport Fleet Impact Model

Run for this impact assessment by

European Commission

Contributed to

Baseline and assessment of policy options

Details of the contribution

Refer to Study: Light duty vehicle CO2 emission reduction cost curves and cost assessment

Further details can be found in:

Krause, J., Donati, A. and Thiel, C., Light Duty Vehicle CO2 Emission Reduction Cost Curves and Cost Assessment - the DIONE Model, EUR 28821 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-74136-4 (online),978-92-79-74137-1 (print), doi:10.2760/87837 (online),10.2760/462088 (print), JRC108725.

E3ME

Full title

Energy - Environment - Economy Model for Europe

Run for this impact assessment by

Cambridge Econometrics

Contributed to

Baseline and assessment of policy options

Details of the contribution

E3ME used together with GEM-E3 to assess macroeconomic and sectoral economic impacts. In particular, these models are used to quantify the impacts of the different CO2 targets for light-duty vehicles on the wider economy, i.e. GDP, sectoral output and employment.

GEM-E3

Full title

General Equilibrium Model - Economy, Energy, Environment

Run for this impact assessment by

Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens

Contributed to

Baseline and assessment of policy options

Details of the contribution

The model has been used by E3MLab/ICCS to provide the macro assumptions for the Reference scenario and for the policy scenarios.

GEM-E3

Full title

General Equilibrium Model - Economy, Energy, Environment

Run for this impact assessment by

European Commission

Contributed to

Baseline and assessment of policy options

Details of the contribution

GEM-E3 was used to assess macroeconomic impacts of target setting based on GDP per capita.

PRIMES-TREMOVE

Full title

PRIMES-TREMOVE Transport Model

Run for this impact assessment by

Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens

Contributed to

Baseline and assessment of policy options

Details of the contribution

The PRIMES-TREMOVE model is used to project the evolution of the road transport sector.

CO2MPAS - CO2 Model for PAssenger and commercial vehicles Simulation

Fact sheet

Source: Commission modelling inventory and knowledge management system (MIDAS)

Date of Report Generation: 20/10/2020

Overview

Acronym CO2MPAS
Full title CO2 Model for PAssenger and commercial vehicles Simulation

Main purpose
CO2MPAS is a vehicle simulation model for the calculation of CO2 emissions, energy, and fuel consumption from passenger cars and light commercial vehicles. It uses experimental data, retrieved from chassis dyno or on-road tests, to simulate the operation of vehicles under different operating conditions.

Summary
CO2MPAS is a technology-based vehicle simulation model developed to estimate CO2 emissions, energy, and fuel consumption of passenger cars and light commercial vehicles. CO2MPAS was developed to calculate CO2 emissions of light duty vehicles over the NEDC test cycle and protocol, using as input, data retrieved from tests performed in accordance with the new emissions type approval test, i.e. WLTP (Worldwide harmonized light vehicles test procedure set out in Commission Regulation (EU) 2017/1151). The WLTP is the new and more realistic procedure for the emission type-approval of light duty vehicles which replaces the old and outdated NEDC procedure starting from 2017. The use CO2MPAS for the purpose of correlating CO2 emissions determined on the NEDC and the WLTP is set out in Commission Implementing Regulations (EU) 2017/1152 (light commercial vehicles) and 2017/1153 (passenger cars). The correlation of CO2 emission values is required to ensure a transition from NEDC based CO2 emission targets to targets based on WLTP emissions under Regulation (EU) 2019/631 setting out CO2 emission performance standards for light duty vehicles.

The CO2MPAS model is able to provide the difference in CO2 emissions under the two different test procedures, thus allowing the evaluation of an NEDC-based CO2 value. For doing so it uses of technical information concerning the technology configuration of a vehicle and the WLTP-based CO2 test results.

As a vehicle simulation tool, the application of CO2MPAS can be used for other purposes than the WLTP/NEDC correlation. Notably, the model can be used to simulate a large number of variations in vehicle configuration, type, characteristics and technology, allowing for a quick estimation of CO2 emissions from different types of light duty vehicles. In this way it might be integrated in i) a traffic simulation model to evaluate the effect on the overall energy/fuel consumption of policies and measures on the transportation system, or ii) to a fleet simulation model to evaluate the effect on energy/fuel consumption due to the introduction of new vehicle technologies.

CO2MPAS is also the simulation model that was used to calculate fuel consumption and CO2 emissions estimates provided by the JRC's Green Driving tool, an on-line tool that calculates realistic fuel consumption values over specific routes depending on a vehicle characteristics (https://green-driving.jrc.ec.europa.eu).

Keywords
road transport , vehicle simulation , CO2 from light duty vehicles

Model category (thematic)
Transport

Model home page
https://co2mpas.io/

Ownership & license

Ownership
Sole copyright [European Union]

Ownership details
The model is being developed and maintained by the JRC.C.4 Unit who entirely owns the intellectual property of the tool.

Licence type
Free software licence. The license grants freedom to run the programme for any purpose; freedom to run the program for any purpose; freedom to study (by accessing the source code) how the program works, and change it so it does enable computing; freedom to redistribute copies; and freedom to distribute copies of modified versions to others.

Details

CO2MPAS structure and approach

CO2MPAS is coded in PYTHON v3.4 computer language. It is based on vehicle longitudinal dynamics and has a modular architecture. It includes a series of predefined algorithms for simulating the operation of various components. It has the capacity to self-calibrate based on given experimental data.

Input and parametrization

The primary use foreseen for the model is to correlate type approval CO2 emissions determined for light duty vehicles in accordance with the new WLTP test procedure set out in Commission Regulation 2017/1151 with the CO2 emissions determined pursuant to the old NEDC test procedure set out in Commission Regulation (EC) No 692/2008. The CO2MPAS model calculates CO2 emissions of light duty vehicles on the NEDC test procedure using as input data retrieved during the vehicle type-approval carried in accordance with the WLTP test procedure (Commission Implementing Regulations (EU) 2017/1152 and 2017/1153, hereinafter 'Correlation Regulations')). The correlation procedure and the model allows the transition from the NEDC to the WLTP without affecting the CO2 targets defined in Regulations 443/2009 and 510/2011 (replaced since 1 January 2020 by Regulation (EU) 2019/631). The model requires an extensive list of inputs, as set out in Table 1 of Annex I to the respective Correlation Regulations, in order to ensure the required level of accuracy in the correlation of the CO2 emission values. The inputs include in brief:

- type of fuel
- engine/powertrain characteristics
- gear-box characteristics
- electric components
- vehicle characteristics
- specific technologies of the vehicle
- the results of the vehicle tested under WLTP conditions.

A number of default input values are defined for vehicle classes for the model to be used for other purposes. For example it might be used to carry out scenario analyses on the effect on global CO2 emissions due to the introduction of specific vehicle technologies in the vehicle fleet, or to assess the effect of modifying some aspects of the vehicle type-approval test. In this case achieving high accuracy on the single estimation is not important and the default values can allow its use to derive aggregated statistics.

Main output

CO2MPAS is able to provide *fuel consumption*, *energy consumption* and *CO2 emissions* for a vehicle following a predefined trajectory. Default simulation conditions are the NEDC and WLTP test procedures, for which it has been designed.

Spatial - temporal extent

The output has the following spatial-temporal resolution and extent:

Parameter	Description
Spatial Extent / Country Coverage	n.a.
(Spatial) resolution	n.a. in its current version. The possibility to integrate it with a traffic simulation model to evaluate fuel consumption and CO2 emissions from a broader traffic scenario (urban/regional level).
Temporal extent	n.a. The possibility to integrate it with a traffic simulation model to evaluate fuel consumption and CO2 emissions in a certain transportation context during a certain period of time (day, the morning peak hours, etc.).
Temporal resolution	The simulation is carried out considering a frequency of 1Hz in the vehicle operations. Higher frequencies can also be accepted.

Quality & transparency

Quality

Question	Answer	Details
Models are by definition affected by uncertainties (in input data, input parameters, scenario definitions, etc.). Have the model uncertainties been quantified? Are uncertainties accounted for in your simulations?	yes	The model is regulated and its calibration is based on experimental data that are generated during the official vehicle certification test. Each new model version is released with a validation report that is available publicly here http://jrcstu.github.io/co2mpas/
Sensitivity analysis helps identifying the uncertain inputs mostly responsible for the uncertainty in the model responses. Has the model undergone sensitivity analysis?	yes	By the JRC the results were presented to the technical working group overlooking CO2MPAS development (see next point).
Has the model undergone external peer review by a panel of experts, or have results been published in peer-reviewed journals?	yes	An ad-hoc technical working group was established by DG CLIMA during the development phase (comprised of industrial and independent stakeholders). Additional external validations are carried out on a yearly basis.
Has model validation been done? Have model predictions been confronted with observed data (ex-post)?	yes	The model is used on a daily basis by type approval authorities across Europe. JRC receives continuous feedback on its operation. In addition to this a dedicated validation based on 50 light duty vehicles has taken place.

References related to external peer-review and publication in scientific journals:

- Fontaras, G., Valverde Morales, V., Arcidiacono, V., Tsiakmakis, S., Anagnostopoulos, K., Komnos, D., Pavlovic, J. and Ciuffo, B., The development and validation of a vehicle simulator for the introduction of Worldwide Harmonized test protocol in the European light duty vehicle CO2 certification process, APPLIED ENERGY, ISSN 0306-2619, 226, 2018, p. 784-796, JRC112017.
- Mogno, C., Fontaras, G., Arcidiacono, V., Komnos, D., Pavlovic, J., Ciuffo, B., … Valverde, V. (2020). The application of the CO2MPAS model for vehicle CO2 emissions estimation over real traffic conditions. Transport Policy. doi:10.1016/j.tranpol.2020.01.005
- Fiori, C., Arcidiacono, V., Fontaras, G., Makridis, M., Mattas, K., Marzano, V., … Ciuffo, B. (2019). The effect of electrified mobility on the relationship between traffic conditions and energy consumption. Transportation Research Part D: Transport and Environment, 67, 275–290. doi:10.1016/j.trd.2018.11.018

Transparency

Question	Answer	Details
Is the model underlying database (i.e. the database the model runs are based on) publicly available?	no	There is no underlying database. Input data to use the tool are technical vehicle information.

Can model outputs be made publicly available?	yes	This is s part of the vehicle certification process.
Is the model transparently documented (including underlying data, assumptions and equations, architecture, results) and are these documents available to the general public?	yes	The software is open source. All its documentation is publicly available on-line under https://co2mpas.readthedocs.io/en/stable/ and
Is the model source code publicly accessible or open for inspection?	yes	It is a JRC developed open-source software. All sources are available on-line under https://co2mpas.readthedocs.io/en/stable/ and http://jrcstu.github.io/co2mpas .

References related to documentation:

- No references provided in MIDAS

The model's policy relevance and intended role in the policy cycle

The model is designed to contribute to the following policy areas

- Climate action
- Institutional affairs
- Energy
- Transport

The model is designed to contribute to the following phases of the policy cycle

- Anticipation
- Formulation
- Implementation
- Evaluation

The model's potential

CO2MPAS is used to analyse the correlation between the CO2 emissions from the Worldwide harmonized light vehicles test procedure (WLTP) and the New European Driving Cycle (NEDC) test procedures. The WLTP is a new test procedure developed at the UN/ECE level that the Commission has introduced (in the place of the NEDC) for the type-approval of passenger cars and light commercial vehicles starting on September 1st, 2017 (EU Regulation 1151/2017). The CO2MPAS model is used by vehicle manufacturers and type-approval authorities during the WLTP phase-in (2017-2020), to calculate the equivalent NEDC CO2 emissions for vehicles tested on the WLTP. In this way, the CO2 emission targets set by Regulation (EU) 2019/631 can remain unchanged in spite of the introduction of the new procedure.

Commission Implementing Regulations 2017/1152 and 2017/1153 provide for the use of CO2MPAS during the vehicle type-approval process.

An extended version of CO2MPAS has been used in the Impact Assessment for the "Review of Regulations setting emission performance standards to establish post-2020 targets for cars and vans" (see [1]) in order to calculate the baseline 2015 CO2 emissions from the European fleet of new passenger cars under WLTP conditions.

CO2MPAS to the Commission Roadmap:

- Primary:
    - CO2MPAS can also be used to provide "Data, analysis and intelligence for the Energy Union: initiative pooling and making easily accessible all relevant knowledge in the Commission and Member States"

- Secondary:
    - CO2MPAS can be used in the "Master Plan for the deployment of Cooperative Intelligent Transport Systems". In particular CO2MPAS can serve as a reference simulation platform, for testing optimization of transport and logistics system in specific cases [2].

The model has been already presented to several international conferences and the results from its use published in different scientific journals and JRC reports.

References:

[1] Tsiakmakis, S., Fontaras, G., Cubito, C., Anagnostopoulos, K., Ciuffo, B., 2017. From NEDC to WLTP: effect on the type-approval CO2 emissions of light-duty vehicles (Science for Policy Report No. EUR 28724 EN). https://doi.org/10.2760/93419

[2] Makridis, M., Mattas, K., Mogno, C., Ciuffo, B., Fontaras, G., 2020. The impact of automation and connectivity on traffic flow and CO2 emissions. A detailed microsimulation study. Atmospheric Environment 226, 117399. https://doi.org/10.1016/j.atmosenv.2020.117399

Previous use of the model in ex-ante impact assessments of the European Commission

Use of the model in ex-ante impact assessments since July 2017.

In the Year	CO2MPAS contributed to the Impact assessment called	Led by	By providing input to the	The model was run by	Details of the contribution
2017	Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council: setting emission performance standards for new passenger cars and for new light commercial vehicles as part of the Union's integrated approach to reduce CO2 emissions from light-duty vehicles and amending Regulation (EC) No 715/2007 (recast) SWD/2017/0650 final	CLIMA	Baseline only	*European Commission*	Co2mpas was used to calculate the baseline 2015 CO2 emissions from the European fleet of new passenger cars under WLTP conditions.

Bibliographic references

- *Mogno, C., Fontaras, G., Arcidiacono, V., Komnos, D., Pavlovic, J., Ciuffo, B., … Valverde, V. (2020). The application of the CO2MPAS model for vehicle CO2 emissions estimation over real traffic conditions. Transport Policy. doi:10.1016/j.tranpol.2020.01.005*

- *Makridis, M., Mattas, K., Mogno, C., Ciuffo, B., & Fontaras, G. (2020). The impact of automation and connectivity on traffic flow and CO2 emissions. A detailed microsimulation study. Atmospheric Environment, 226, 117399. doi:10.1016/j.atmosenv.2020.117399*

- *Fiori, C., Arcidiacono, V., Fontaras, G., Makridis, M., Mattas, K., Marzano, V., … Ciuffo, B. (2019). The effect of electrified mobility on the relationship between traffic conditions and energy consumption. Transportation Research Part D: Transport and Environment, 67, 275–290. doi:10.1016/j.trd.2018.11.018*

- *Fontaras, G., Valverde Morales, V., Arcidiacono, V., Tsiakmakis, S., Anagnostopoulos, K., Komnos, D., Pavlovic, J. and Ciuffo, B., The development and validation of a vehicle simulator for the introduction of Worldwide Harmonized test protocol in the European light duty vehicle CO2 certification process, APPLIED ENERGY, ISSN 0306-2619, 226, 2018, p. 784-796, JRC112017.*

- *Pavlovic, J., Ciuffo, B., Fontaras, G., Valverde Morales, V. and Marotta, A., How much difference in type-approval CO2 emissions from passenger cars in Europe can be expected from changing to the new test procedure (NEDC vs. WLTP) , TRANSPORTATION RESEARCH PART A-POLICY AND PRACTICE, ISSN 0965-8564, 111, 2018, p. 136-147, JRC111320.*

- *Tsiakmakis S; Fontaras G; Ciuffo B; Samaras Z. A simulation-based methodology for quantifying European passenger car fleet CO2 emissions. APPLIED ENERGY 199; 2017. p. 447-465. JRC106457*

- *Tsiakmakis, S., Fontaras, G., Cubito, C., Pavlovic, J., Anagnostopoulos, K. and Ciuffo, B., From NEDC to WLTP: effect on the type-approval CO2 emissions of light-duty vehicles, EUR 28724 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-71642-3 (pdf),978-92-79-71643-0 (print), doi:10.2760/93419 (online),10.2760/35344 (print), JRC107662.*

- *Ciuffo B and Fontaras G. Models and scientific tools for regulatory purposes: the case of CO2 emissions from light duty vehicles in Europe. ENERGY POLICY 109; 2017. p. 76-81. JRC107225*

- *Fontaras G; Zacharof N; Ciuffo B. Fuel Consumption and CO2 Emissions from Passenger Cars in Europe - Laboratory versus Real-World Emissions. PROGRESS IN ENERGY AND COMBUSTION SCIENCE 60; 2017. p. 97-131. JRC104983*

- *Tsiakmakis, S., Ciuffo, B., Fontaras, G., Anagnostopoulos, K., Arcidiacono, V., Praksova, R., & Marotta, A. (2016). Introducing a New Emissions Certification Procedure for European Light-Duty Vehicles. Transportation Research Record: Journal of the Transportation Research Board, 2572, 66–77. doi:10.3141/2572-08*

- *Fontaras, G., Ciuffo, B., Zacharof, N., Tsiakmakis, S., Marotta, A., Pavlovic, J. and Anagnostopoulos, K., The difference between reported and real-world CO2 emissions: How much improvement can be expected by WLTP introduction , In: World Conference on Transport Research, 10-15 July 2016, Shanghai, World Conference on Transport Research, 2017, ISSN 2352-1465, 25, p. 3933-3943, JRC104702.*

- *Arcidiacono V; Tsiakmakis S; Fontaras G; Ciuffo B; Valverde Morales V; Pavlovic J; Anagnostopoulos K. CO2MPAS: Vehicle simulator predicting NEDC CO2 emissions from WLTP. European Commission; 2016. JRC104432*

DIONE- Road Transport Fleet Impact Model

Fact sheet

Source: Commission modelling inventory and knowledge management system (MIDAS)

Date of Report Generation: 20/10/2020

Overview

Acronym DIONE
Full title Road Transport Fleet Impact Model

Main purpose
DIONE can support road transport related policies by assessing the implications of future road vehicle fleet composition and drive patterns on energy consumption, emissions and total costs of ownership.

Summary
The **DIONE Fleet Impact Model** is used to assess the impacts of changes in the European and MS road transport fleet characteristics up to the year 2050. It is a flexible tool which can be employed to analyse scenarios on road vehicle stock development and composition, vehicle activity and driving patterns, and vehicle technology and fuel use trends. The model contains a calibrated baseline which is consistent with the country-specific stock and activity data collected in the project TRACCS, and is taken forward following the trends of a PRIMES baseline scenario. Fuel consumption and emission calculation for combustion engine vehicles is based on COPERT methodology. For alternative fuel vehicles, an energy and emission calculation methodology has been developed which takes account of vehicle characteristics, trip lengths and speed distributions. For both energy consumption and greenhouse gas (GHG) emissions, DIONE can provide real world Tank-to-Wheel (TtW) up to the year 2050 as well as Well-to-Wheel (WtW) results up to 2030.

The **DIONE cost curve model** is employed for developing cost curves which describe the costs associated with reaching a given CO2 standard, for a given vehicle segment and powertrain. Cost curves are constructed by identifying cost-optimal bundles of technologies for CO2 reduction and then fitting a continuous cost curve.

The **DIONE Cross-optimization module** identifies cost-optimal strategies to reach given emission targets, building on the cost curves. Cross-optimization outcomes can be used to assess the impact of different policy options on manufacturing costs for different manufacturers and the market as a whole.

The **DIONE Total Cost of Ownership Module** computes total costs of ownership for different vehicle types and powertrains, summarizing the results from the previous steps and adding fuel/energy costs and maintenance costs. This allows assessing the societal costs associated with a policy option, as well as costs for consumers (new vehicle buyers and second-hand vehicle buyers).

DIONE can be used for ex-ante policy support. All DIONE modules are employed to provide policy support in the context of decarbonisation and electrification of road transport, as well as for assessing possible transitions towards alternative fuels for road transport.

Keywords

transport model , road transport , scenario analysis , electromobility , CO2 emissions , alternative fuels , energy consumption , air pollutant emissions , Cost Curve , Total Costs of Ownership

Model category (thematic)
No information provided

Model home page
No information provided

Ownership & license

Ownership
Multiple copyright [Original code owned by 3rd party]

Ownership details
Code based on 3rd party

Licence type
Non-Free Software licence. The license has one or more of the following restrictions: it prohibits creation of derivative works; it prohibits commercial use; it obliges to share the licensed or derivative works on the same conditions.

Details

DIONE structure and approach

The DIONE model uses a modular structure which allows to add new functionalities as more data becomes available and as policy needs arise. Model development originally started with the DIONE fleet impact model, which is used to calculate road transport fuel and energy consumption and emissions for future fleet development scenarios. The model presently consists of the following modules, which can be used either standalone or in combinations, and cover a broad range of road vehicles (cars, vans, trucks):

- DIONE Fleet Impact Model
- DIONE COPERT module (under development)
- DIONE Cost Curve Module
- DIONE Cross-Optimization Module
- DIONE Fuel and Energy Cost Module
- DIONE TCO and Payback Module

Input and parametrization

Parametrisation: The DIONE fleet impact model contains a calibrated stock baseline which is consistent with the country-specific stock and activity data collected in the project TRACCS, and is taken forward following the trends of PRIMES 2012 baseline scenario with adopted measures.

Fuel consumption and emission calculation for combustion engine vehicles is based on COPERT 4 v.11 road transport emission inventory software. For alternative fuel vehicles, an energy and emission calculation methodology has been developed which takes account of vehicle characteristics, trip lengths and speed distributions.

Inputs:

Main variables that can be defined by the user include:

- vehicle stock,
- new registrations,
- survival rates,
- activity,
- efficiency improvement,

- fuel use of flex-fuel vehicles,
- fuel pathways for well-to-wheel energy consumption and emissions,
- biofuel admixture shares for conventional fuels,
- driving patterns.

Users can define custom scenarios either by adapting baseline values in the DIONE input tables or graphical user interface graphs, or by uploading input files. The user can decide to create a scenario for any predefined entity, i.e., any single EU member state (plus some extra neighbour countries), pre-defined groupings such as EU28, EU15 and EU12, but can also decide to define a custom scenario for any region, city, country or other entity of interest.

The DIONE Cost Curve Module uses data on vehicle efficiency improvement technologies (their efficiencies, costs and compatibilities) as additional inputs, whereas the DIONE Fuel and Energy Cost Module needs to be fed with energy price estimates. For Cross-Optimization and TCO/Payback Calculations, Fleet Composition scenarios can be aligned with DIONE fleet impact model runs or provided from other sources.

Main output

The output of the DIONE fleet impact model contains fleet development and activity, energy demand, CO2 emissions, other GHGs and all air pollutants included in the COPERT methodology.

For both energy consumption and greenhouse gas (GHG) emissions, DIONE can provide real world tank-to-wheel (TtW) figures up to the year 2050 as well as well-to-wheel (WtW) results up to 2030. For CO2 emissions, NEDC type approval values can be calculated, as well. DIONE also includes a cost module which determines additional costs for achieving given efficiency targets for conventional passenger cars.

DIONE can be used for policy-relevant scenario analysis, including analysis of the following options:

- Fuel efficiency targets
- Technology replacement, Stock composition or new registration technology share targets
- Biofuel Admixture
- Fuel GHG intensities
- Scrappage Schemes
- Vehicle Activity

The further modules provide additional outputs such as

- Cost-optimal segment and powertrain-specific CO2 reductions and related costs

- Fuel and energy costs of vehicle types and fleets
- Total costs of ownership for vehicles within a given scenario,
- Payback times for efficiency technology

Spatial - temporal extent

The output has the following spatial-temporal resolution and extent:

Parameter	Description
Spatial Extent / Country Coverage	28 EU MS, Iceland, Norway, Switzerland, Former Yugoslav Republic of Macedonia, Turkey
(Spatial) resolution	Several possible aggregation levels: National, EU28, EU15, EU12, Non-EU
Temporal extent	2010-2050
Temporal resolution	yearly

Quality & transparency

Quality

Question	Answer	Details
Models are by definition affected by uncertainties (in input data, input parameters, scenario definitions, etc.). Have the model uncertainties been quantified? Are uncertainties accounted for in your simulations?	no	Most of the DIONE modules are deterministic, such that uncertainties relate mainly to the quality of input data, which is hard to quantify and quality checks of which remain with data providers. The DIONE Cost Curve Model uses random and probabilistic elements in the exploration process for determining optimal technology packages, which according to internal test have very little impact on the final cost curves.
Sensitivity analysis helps identifying the uncertain inputs mostly responsible for the uncertainty in the model responses. Has the model undergone sensitivity analysis?	yes	Sensitivities of model results have been explored before making use of the model, and by verifying the response of model outcomes to the variation of input parameters during intensive scenario calculation.
Has the model undergone external peer review by a panel of experts, or have results been published in peer-reviewed journals?	no	The model code is under development and cannot presently be shared outside the Commission.
Has model validation been done? Have model predictions been confronted with observed data (ex-post)?	no	Model projections regard future years and cannot yet be confronted with observed data.

References related to external peer-review and publication in scientific journals:

- No references provided in MIDAS

Transparency

Question	Answer	Details
Is the model underlying database (i.e. the database the model runs are based on) publicly available?	yes	Most modules rely extensively on publicly available data. Input data used for the Cost Curves and total costs of ownership calculations is referenced in the respective JRC reports.
Can model outputs be made publicly available?	yes	Some fleet model outputs are summarized in papers; all final JRC cost curves as well as exemplary total cost of ownership (TCO) results are specified in the respective JRC reports; central TCO results have been included in the impact assessments for CO2 standards for LDV and HDV.
Is the model transparently documented (including underlying data, assumptions and equations, architecture, results) and are these documents available to the general public?	yes	The cost curve model, cross-optimization module and TCO module documentation have been published in two JRC reports (for LDV and HDV respectively). For the fleet impact model, an updated model version is under development, publication of the model documentation outstanding.
Is the model source code publicly accessible or open for inspection?	no	The model code is under development and cannot presently be shared outside the Commission.

References related to documentation:

- Krause, J. and Donati, A., Heavy duty vehicle CO2 emission reduction cost curves and cost assessment – enhancement of the DIONE model, EUR 29284 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-88812-0, doi:10.2760/555936, JRC112013.
- Krause, J., Donati, A. and Thiel, C., Light Duty Vehicle CO2 Emission Reduction Cost Curves and Cost Assessment - the DIONE Model, EUR 28821 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-74136-4 (online),978-92-79-74137-1 (print), doi:10.2760/87837 (online),10.2760/462088 (print), JRC108725.

The model's policy relevance and intended role in the policy cycle

The model is designed to contribute to the following policy areas

- Climate action
- Energy
- Environment
- Transport

The model is designed to contribute to the following phases of the policy cycle

- Anticipation
- Formulation

The model's potential

The model is employed to provide policy support in the context of decarbonisation and electrification of road transport, as well as for assessing possible transitions towards alternative fuels for road transport in general.

It has been used in support of the **Impact Assessment for post-2020 emissions standards for cars and vans (2017)** supporting DG CLIMA, for the **Assessment of National Framework Plans under the Alternative Fuels Infrastructure Directive (2017)** supporting DG MOVE, and for the support of the **Impact Assessment on fuel efficiency standards for heavy-duty vehicles (2018)** supporting DG CLIMA. Previously, it has been employed to prepare scenarios as an input for the EC **Communication on decarbonising the transport sector**. Furthermore, it was recently used to calculate road transport energy consumptions for a 2050 scenario study within the ERTRAC CO2 working group. Further work is under way to soft-link DIONE emission calculation and cost curves with JRC's POTEnCIA model and employ it for scenario analysis on behalf of DG MOVE.

It can also be used to assess scenarios on the electrification of transport in line with the **Energy Union** strategy, to analyse possible transport sector measures for implementing a new **effort sharing decision**, as well as for reaching the **Transport White Paper** carbon emission reduction and conventional vehicle phase-out goals.

Previous use of the model in ex-ante impact assessments of the European Commission

Use of the model in ex-ante impact assessments since July 2017.

In the Year	DIONE contributed to the Impact assessment called	Led by	By providing input to the	The model was run by	Details of the contribution
2018	Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council: setting CO2 emission performance standards for new heavy duty vehicles SWD/2018/185 final	CLIMA	Baseline and assessment of policy options	*European Commission*	Refer to Study: Heavy duty vehicle CO2 emission reduction cost curves and cost assessment – enhancement of the DIONE model Documented in: - DOI 10.2760/555936
2017	Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council: setting emission performance standards for new passenger cars and for new light commercial vehicles as part of the Union's integrated approach to reduce CO2 emissions from light-duty vehicles and amending Regulation (EC) No 715/2007 (recast) SWD/2017/0650 final	CLIMA	Baseline and assessment of policy options	*European Commission*	Refer to Study: Light duty vehicle CO2 emission reduction cost curves and cost assessment Documented in: - DOI 10.2760/87837

Bibliographic references

- *Krause, J. and Donati, A., Heavy duty vehicle CO2 emission reduction cost curves and cost assessment – enhancement of the DIONE model, EUR 29284 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-88812-0, doi:10.2760/555936, JRC112013.*

- *Krause, J., Donati, A. and Thiel, C., Light Duty Vehicle CO2 Emission Reduction Cost Curves and Cost Assessment - the DIONE Model, EUR 28821 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-74136-4 (online),978-92-79-74137-1 (print), doi:10.2760/87837 (online),10.2760/462088 (print), JRC108725.*

- *Harrison, G., Krause, J., & Thiel, C. (2016). Transitions and Impacts of Passenger Car Powertrain Technologies in European Member States. Transportation Research Procedia, 14, 2620–2629. doi:10.1016/j.trpro.2016.05.418*

- *Thiel, C., Drossinos, Y., Krause, J., Harrison, G., Gkatzoflias, D., & Donati, A. V. (2016). Modelling Electro-mobility: An Integrated Modelling Platform for Assessing European Policies. Transportation Research Procedia, 14, 2544–2553. doi:10.1016/j.trpro.2016.05.341*

E3ME - Energy - Environment - Economy Model for Europe

Fact sheet

Source: Commission modelling inventory and knowledge management system (MIDAS)

Date of Report Generation: 20/10/2020

Overview

Acronym E3ME
Full title Energy - Environment - Economy Model for Europe

Main purpose
A macro-econometric model used to simulate and assess the medium to long-term effects of environmental and economic policies for Europe.

Summary
The E3ME model is used to simulate and assess the medium to long-term effects of environmental and economic policies, and covering explicitly Europe at Member State level (incl. Croatia), three EU candidate countries, Norway Switzerland and UK, 11 other major economies while the rest of the world is grouped into political regions. The model can be solved until 2050. The first version was built by an international European team under a succession of contracts in the 1980s and 1990s under EEC/EU research programmes (such as JOULE/THERMIE). The current version of the model was developed by Cambridge Econometrics.

E3ME is a macro-econometric model which comprises the accounting framework of the economy, based on the ESA95 system of national accounts, coupled with balances for energy and material demands and environmental emission flows, detailed historical data sets, with time series covering the period since 1970 and sectoral disaggregation using the NACE classification of economic activities at 2-digit level. E3ME has an econometric specification of behavioural relationships in which short-term deviations move towards long-term trends.

E3ME can be used for impact assessments, and has been used for several recent high-profile assessments, including an assessment of the impacts of high oil prices on the global economy for the 2009, input to the EU's Impact Assessment of the revised Energy Taxation Directive or input to the EU's Impact Assessment of the Energy Efficiency Directive.

Keywords
energy system model , environmental policies , econometric input-output model , resource consumption

Model category (thematic)
Economy

Model home page
http://www.camecon.com/how/e3me-model/

Ownership & license

Ownership
Sole copyright [3rd party]

Ownership details
Cambridge Econometrics

Licence type
Non-Free Software licence. The license has one or more of the following restrictions: it prohibits creation of derivative works; it prohibits commercial use; it obliges to share the licensed or derivative works on the same conditions.

Details

E3ME structure and approach

The structure of E3ME is based on the system of national accounts, as defined by the ESA 95 system [1], with further linkages to energy demand and environmental emissions. The labour market is also covered in detail, with estimated sets of equations for labour demand, supply, wages and working hours. In total there are 29 sets of econometrically estimated equations, also including the components of GDP (consumption, investment, international trade), prices, energy demand and materials demands. Each equation set is disaggregated by country and by sector. E3ME's historical database covers the period 1970-2010 and the model projects forward annually to 2050. The main data sources are Eurostat, DG ECFIN AMECO database and the IEA, supplemented by the OECD's STAN database and other sources where appropriate. Gaps in the data are estimated using customised software algorithms.

The model covers 69 economic sectors, 43 categories of household expenditure, 22 different users of 12 different fuel types,16 different material users of 8 different mineral material types plus water, 14 types of air-borne emissions (where data are available) including the six greenhouse gases monitored under the Kyoto protocol, 13 types of household, including income quintiles and socio-economic groups such as the unemployed, inactive and retired, plus an urban/rural split.

[1] https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:European_system_of_national_and_regional_accounts_(ESA95)

Input and parametrization

There are three categories of inputs to the model: (time series) data, assumptions on basic economic parameters and values, and scenario variables describing the policy option that is to be examined. Data include

- output (constant and current price bases)
- Gross Value Added (GVA) at market prices and factor cost
- investment
- R&D spending
- household expenditure (by product)
- government final consumption (by category)
- exports
- imports
- employment

- labour costs (current prices)
- average working hours.

In addition, there are time series for population and labour force.

Assumptions include:

- market exchange rate, local currency per dollar, current prices
- long-run interest rate
- short-run interest rate (only used for comparative purposes)
- change in government final consumption, year on year
- % of government consumption spent on defence, education and health
- standard VAT rate
- aggregate rate of direct taxes
- average indirect tax rates
- ratio of benefits to wages (giving implicit rate)
- employees' social security rate
- employers' social security rate

Policy options can be described using the following parameters:

- annual CO2 tax rate, € per tonne of carbon
- annual EU ETS allowance prices, € per tonne of carbon (if level of ETS caps are unknown)
- annual ETS emissions caps, thousand tonnes of carbon
- switches to include different energy users in the policies
- switches to include different fuel types in the policies
- switch to set EU ETS policy to use caps (endogenous price) or exogenous ETS
- prices
- annual energy tax rate, € per toe
- switches to include different users in policies

- switch to include different fuel types in policies
- switch to differentiate tax rates for different groups, e.g. industries or households
- annual material tax rates for seven types of materials, in percentage cost increase
- switches to include different material users in policies

In addition, the model includes options to recycle automatically the revenues generated from carbon taxes, energy taxes, ETS (with auctioned allowances) and materials taxes. There are two options in the model for how the revenues are recycled:

- To lower employers' social security contributions;
- To lower income tax;
- To increase levels of R&D spending.

Main output
Outputs produced by the model include:

- GDP and its aggregate components (household expenditure, investment, government expenditure and international trade)
- sectoral output and Gross Value Added (GVA), prices, trade and competitiveness effects
- international trade by sector, origin and destination
- consumer prices and expenditures
- sectoral employment, unemployment, sectoral wage rates and labour supply
- energy demand, by sector and by fuel, energy prices
- CO2 emissions by sector and by fuel
- other air-borne emissions
- material demands

E3ME is capable of producing a broad range of economic, energy and environment indicators. The following list provides a summary of the most common outputs: GDP and its aggregate components (household expenditure, investment, government expenditure and international trade) sectoral output and GVA, prices, trade and competitiveness effects on consumer prices and expenditures, and implied household distributional effects sectoral employment, unemployment, sectoral wage rates and labour supply energy demand, by sector and by fuel, energy prices, CO2 emissions by sector and by fuel other airborne emissions material demands. Each of these is available at national

and EU levels, and most are also defined by economic sector. This list is by no means exhaustive and the delivered outputs often depend on the requirements of the specific analysis. In addition to the sectoral dimension mentioned in the list, all indicators are produced at the Member State level and annually over the period up to 2050. The measures of endogenous technical change that are included in E3ME are allowed to influence key economic relationships, as well as energy and material demands.

Spatial - temporal extent

The output has the following spatial-temporal resolution and extent:

Parameter	Description
Spatial Extent / Country Coverage	EU27, Norway, Switzerland, UK, Iceland, Turkey and Macedonia
(Spatial) resolution	At national level
Temporal extent	E3ME's historical database covers the period 1970-2010 and the model projects forward annually to 2050.
Temporal resolution	annually

Quality & transparency

Quality

Question	Answer	Details
Models are by definition affected by uncertainties (in input data, input parameters, scenario definitions, etc.). Have the model uncertainties been quantified? Are uncertainties accounted for in your simulations?	yes	The model can be run multiple times (automatically) to test sensitivity to assess uncertainty or test model properties.
Sensitivity analysis helps identifying the uncertain inputs mostly responsible for the uncertainty in the model responses. Has the model undergone sensitivity analysis?		Information not provided
Has the model undergone external peer review by a panel of experts, or have results been published in peer-reviewed journals?	yes	Several peer-reviewed publications have been made by the developers of the model. References on www.camecon.com . For a recent model version published in peer reviewed journal see Mercure et al (2018).
Has model validation been done? Have model predictions been confronted with observed data (ex-post)?		Information not provided

References related to external peer-review and publication in scientific journals:

- Mercure, J.-F., Pollitt, H., Edwards, N. R., Holden, P. B., Chewpreecha, U., Salas, P., … Vinuales, J. E. (2018). Environmental impact assessment for climate change policy with the simulation-based integrated assessment model E3ME-FTT-GENIE. Energy Strategy Reviews, 20, 195–208. doi:10.1016/j.esr.2018.03.003

Transparency

Question	Answer	Details
Is the model underlying database (i.e. the database the model runs are based on) publicly available?	yes	Data are from publicly available sources such as OECD, Eurostat and AMECO.
Can model outputs be made publicly available?	yes	Depending on contract.
Is the model transparently documented (including underlying data, assumptions and equations, architecture, results) and are these documents available to the general public?	yes	The model documentation is available at https://www.e3me.com (https://www.e3me.com/what/e3me/). This fact sheet is based on version 6.1 of the technical manual. Version 7.0 will be published at the same location at some point in 2020.
Is the model source code publicly accessible or open for inspection?	no	The model code is not publicly accessible.

References related to documentation:

- No references provided in MIDAS

The model's policy relevance and intended role in the policy cycle

The model is designed to contribute to the following policy areas

- Climate action
- Institutional affairs
- Economy, finance and the euro
- Energy
- Environment

The model is designed to contribute to the following phases of the policy cycle

- Formulation
- Evaluation

The model's potential

Although E3ME can be used for forecasting, the model is more commonly used for evaluating the impacts of an input shock through a scenario-based analysis. The shock may be either a change in policy, a change in economic assumptions or another change to a model variable. The analysis can be either forward looking (ex-ante) or evaluating previous developments in an ex-post manner. Scenarios can be used either to assess policy, or to assess sensitivities to key inputs, such as international energy prices.

The model provides support for the resource efficiency flagship initiative and sustainability assessment.

Previous use of the model in ex-ante impact assessments of the European Commission

Use of the model in ex-ante impact assessments since July 2017.

In the Year	E3ME contributed to the Impact assessment called	Led by	By providing input to the	The model was run by	Details of the contribution
2020	Impact Assessment accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Stepping up Europe's 2030 climate ambition SWD/2020/176 final	CLIMA	Baseline and assessment of policy options	*Cambridge Econometrics*	E3ME is used for macroeconomic assessment.
2017	Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council: setting emission performance standards for new passenger cars and for new light commercial vehicles as part of the Union's integrated approach to reduce CO2 emissions from light-duty vehicles and amending Regulation (EC) No 715/2007 (recast) SWD/2017/0650 final	CLIMA	Baseline and assessment of policy options	*Cambridge Econometrics*	E3ME used together with GEM-E3 to assess macroeconomic and sectoral economic impacts. In particular, these models are used to quantify the impacts of the different CO2 targets for light-duty vehicles on the wider economy, i.e. GDP, sectoral output and employment.

Bibliographic references

- *Mercure, J.-F., Pollitt, H., Edwards, N. R., Holden, P. B., Chewpreecha, U., Salas, P., … Vinuales, J. E. (2018). Environmental impact assessment for climate change policy with the simulation-based integrated assessment model E3ME-FTT-GENIE. Energy Strategy Reviews, 20, 195–208. doi:10.1016/j.esr.2018.03.003*
- *Rosenbaum E, Vasta A, Ciuffo B. Model-based Development of Scenarios for a Sustainable Europe - Methodologies, assumptions and first results. EUR 27727. Luxembourg (Luxembourg): Publications Office of the European Union; 2015. JRC96495*

GEM-E3 - General Equilibrium Model - Economy, Energy, Environment

Fact sheet

Source: Commission modelling inventory and knowledge management system (MIDAS)

Date of Report Generation: 20/10/2020

Overview

Acronym GEM-E3
Full title General Equilibrium Model - Economy, Energy, Environment

Main purpose:
A macro-economic model used to assess energy, climate and air quality policies.

Summary
The GEM-E3 model is a global multi-sectoral general equilibrium model. GEM-E3 covers the interactions between the economy, the energy system and the environment. The model is used to calculate macro-economic impacts such as GDP, welfare, consumption, trade, employment, sectoral output, and carbon price.

It covers all EU Member States and the rest of the world, which is divided into 19 major economies. Countries are linked through endogenous bilateral trade. The calibration of the model is based on the GTAP database and uses techno-economic inputs from sectoral models such as POTEnCIA, PRIMES, POLES, GAINS, and GLOBIOM. The model simultaneously computes the equilibrium prices of goods, services, labour, capital and tradable emission rights such that all markets are in equilibrium. It integrates micro-economic behaviour into a macro-economic framework and allows assessing the medium to long-term implications of policies. The model evaluates the emissions of carbon dioxide (CO2) and other GHG (e.g. CH4). There are three mechanisms of emission reduction: (i) substitution between fuels, and between energetic and non-energetic inputs, (ii) emission reduction due to less production and consumption, and (iii) purchasing abatement equipment.

The model can be used for policy anticipation, formulation and implementation to assess macro-economic impacts of energy, climate and air quality policies. The model has been used, among others, for the Impact Assessments of the 2030 Framework of Energy and Climate Policies, its implementation in the context of the Energy Union, the Paris Agreement, and the Clean Air Package.

Keywords
Energy , Environment , Climate , General equilibrium , Climate policy , Air Pollution

Model category (thematic)
Economy

Model home page
https://ec.europa.eu/jrc/gem-e3

Ownership & license

Ownership
Joint copyright

Ownership details
The ownership is shared with the institutions that developed the model and the JRC, European Commission: a) Institute of Communication and Computer Systems - National Technical University of Athens (ICCS/NTUA); b) CES, Centre for Economic Studies, Katholieke Universiteit Leuven c) DG JRC, European Commission (C6) which has developed various modules for GEM-E3, as well as extended and updated the supporting databases (incl. GTAP).

Licence type
Non-Free Software licence. The license has one or more of the following restrictions: it prohibits creation of derivative works; it prohibits commercial use; it obliges to share the licensed or derivative works on the same conditions.

Details

GEM-E3 structure and approach
GEM-E3 can be used for policy anticipation, formulation and implementation.

In terms of anticipation and formulation, as applied general equilibrium model covering the interactions between the Economy, the Energy system and the Environment with high level of details, the GEM-E3 Model is well suited to assess the impact of climate, energy, and transport regulations, as well as fiscal, air quality, and labour market policies. It can simulate the welfare effects of alternative regulation regimes as well as the consequences of emission targets.

The Clean Air Programme for Europe envisages a regular update of the impact assessment analysis, to track progress towards the objectives of the Directive and to serve as input into the regular Clean Air Forum. In 2018 GEM-E3 was used to update the Impact Assessment during the implementation phase. For more information see http://ec.europa.eu/environment/air/clean_air/outlook.htm. Results featured in the First Clean Air Outlook.

One of the applications of the model includes an economic and employment impact assessment of different EU decarbonisation scenarios for 2050. This is included in the in-depth analysis accompanying the European Commission's *Clean Planet for All* communication of 2018. See https://ec.europa.eu/clima/policies/strategies/2050_en#tab-0-1

See https://ec.europa.eu/jrc/en/gem-e3 for latest updates.

Input and parametrization

- Input/Output tables and SAM (GTAP, Eurostat)
- Energy balances (International Energy Agency, IEA)
- Elasticity of Substitution and Armington elasticity (economic literature)
- Costs of Abatement Technology (Research Projects)
- Emission coefficients (Research Projects)
- Techno-economic inputs from sectoral models such as POTEnCIA, PRIMES, POLES, GAINS, and GLOBIOM

Main output
GEM-E3 analyzes the economic and distributional effects of environmental and economic policies for sectors, agents and regions. The output of GEM-E3 includes projections of

- input-output tables
- employment

- trade
- capital flows
- government revenues
- household consumption
- energy use
- atmospheric emissions.

The model allows the evaluation of the welfare and distributional effects of various environmental policy scenarios, including different burden sharing scenarios, environmental instruments (i.e. taxes, pollution permits or command-and-control policy) and revenue recycling scenarios.

Spatial - temporal extent

The output has the following spatial-temporal resolution and extent:

Parameter	Description
Spatial Extent / Country Coverage	Global coverage; EU 27 Member States + UK and 18 World Regions
(Spatial) resolution	Country level for each of the 27 EU Member States and for 8 non-EU countries; regional resolution for the rest of the world
Temporal extent	Currently, typical runs go up to 2050 (but can be extended beyond if there is a need to)
Temporal resolution	The model is solved in 5-year steps

Quality & transparency

Quality

Question	Answer	Details
Models are by definition affected by uncertainties (in input data, input parameters, scenario definitions, etc.). Have the model uncertainties been quantified? Are uncertainties accounted for in your simulations?	yes	Policy uncertainty is covered by running several scenarios in a what-if fashion
Sensitivity analysis helps identifying the uncertain inputs mostly responsible for the uncertainty in the model responses. Has the model undergone sensitivity analysis?	yes	Sensitivity of output results is done on ad-hoc basis
Has the model undergone external peer review by a panel of experts, or have results been published in peer-reviewed journals?	yes	The output published in academic papers and presented on academic conferences have been reviewed by peers. In addition, separate versions of the model are run independently by JRC and NTUA / E3M-Lab in Athens, enabling comparison of findings and investigation of differences.
Has model validation been done? Have model predictions been confronted with observed data (ex-post)?	yes	As the model does not aim to predict the future, we mainly validate the model through results with our peer group. In addition, elasticity parameters are based on historical data to validate partial model responses, such as reactions to changes in energy prices

References related to external peer-review and publication in scientific journals:

- Vandyck T; Keramidas K; Saveyn B; Kitous A; Vrontisi Z. A global stocktake of the Paris pledges: Implications for energy systems and economy. GLOBAL ENVIRONMENTAL CHANGE-HUMAN AND POLICY DIMENSIONS 41; 2016. p. 46-63. JRC101134
- Vandyck, T., Keramidas, K., Kitous, A., Spadaro, J., Van Dingenen, R., Holland, M. and Saveyn, B., Air quality co-benefits for human health and agriculture counterbalance costs to meet Paris Agreement pledges, NATURE COMMUNICATIONS, ISSN 2041-1723 (online), 9, 2018, p. 4939, JRC111245.

Transparency

Question	Answer	Details
Is the model underlying database (i.e. the database the model runs are based on) publicly available?	yes	The core data, GTAP, are publicly available (if purchased) Other major inputs like IEA energy balances etc. are as well. The input-output tables for future years are published and freely available for the GECO report (from 2018 onwards).
Can model outputs be made publicly available?	yes	Output usually is published in Report and academic papers. Most of them can be downloaded from https://ec.europa.eu/jrc/en/gem-e3/publications

		More detailed output can be published upon request
Is the model transparently documented (including underlying data, assumptions and equations, architecture, results) and are these documents available to the general public?	yes	See model documentation. JRC C.6 published a complete manual as an open-access Technical Report in 2013 with a detailed description of the model. Documentation of the NTUA/E3M-Lab version is also available online under http://www.e3mlab.eu/e3mlab/index.php?option=com_content&view=article&id=56%3Amanual-of-gem-e3-model&catid=36%3Agem-e3&Itemid=71&lang=en
Is the model source code publicly accessible or open for inspection?	no	The GAMS model code is not published as such, but can be replicated from the published set of equations.

References related to documentation:

- Capros P, Van Regemorter D, Paroussos L, Karkatsoulis P, Fragkiadakis C, Tsani S, Charalampidis I, Revesz T, authors Perry M, Abrell J, Ciscar Martinez J, Pycroft J, Saveyn B, editors. GEM-E3 Model Documentation. EUR 26034. Luxembourg (Luxembourg): Publications Office of the European Union; 2013. JRC83177

The model's policy relevance and intended role in the policy cycle

The model is designed to contribute to the following policy areas

- Climate action
- Taxation
- Employment and social affairs
- Energy
- Environment
- Transport

The model is designed to contribute to the following phases of the policy cycle

- Anticipation
- Formulation
- Implementation

The model's potential

GEM-E3 can be used for policy anticipation, formulation and implementation.

In terms of anticipation and formulation, as applied general equilibrium model covering the interactions between the Economy, the Energy system and the Environment with high level of details, the GEM-E3 Model is well suited to assess the impact of climate, energy, and transport regulations, as well as fiscal, air quality, and labour market policies. It can simulate the welfare effects of alternative regulation regimes as well as the consequences of emission targets.

The Clean Air Programme for Europe envisages a regular update of the impact assessment analysis, to track progress towards the objectives of the Directive and to serve as input into the regular Clean Air Forum. In 2018 GEM-E3 is used to update the Impact Assessment during the implementation phase. For more information see http://ec.europa.eu/environment/air/clean_air/outlook.htm. Results featured in the First Clean Air Outlook.

One of the applications of the model includes an economic and employment impact assessment of the European Commission's strategic long-term vision for greenhouse gas reductions, a document that sets the stage for the debate on the long-term climate policy in the EU.

Concerning contributions to Impact Assessments see www.gem-e3.net for latest updates.

Previous use of the model in ex-ante impact assessments of the European Commission

Use of the model in ex-ante impact assessments since July 2017.

In the Year	GEM-E3 contributed to the Impact assessment called	Led by	By providing input to the	The model was run by	Details of the contribution
2020	Impact Assessment accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Stepping up Europe's 2030 climate ambition SWD/2020/176 final	CLIMA	Baseline and assessment of policy options	*Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens*	GEM-E3 is used for macroeconomic assessment.
2017	Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council: setting emission performance standards for new passenger cars and for new light commercial vehicles as part of the Union's integrated approach to reduce CO2 emissions from light-duty vehicles and amending Regulation (EC) No 715/2007 (recast) SWD/2017/0650 final	CLIMA	Baseline and assessment of policy options	*Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens*	The model has been used by E3MLab/ICCS to provide the macro assumptions for the Reference scenario and for the policy scenarios.
2017	Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council: setting emission performance standards for new passenger cars and for new light commercial vehicles as part of the Union's integrated approach to reduce CO2 emissions from light-duty vehicles and amending Regulation (EC) No 715/2007 (recast) SWD/2017/0650 final	CLIMA	Baseline and assessment of policy options	*European Commission*	GEM-E3 was used to assess macroeconomic impacts of target setting based on GDP per capita.

Bibliographic references

- *Vandyck, T., Keramidas, K., Kitous, A., Spadaro, J., Van Dingenen, R., Holland, M. and Saveyn, B., Air quality co-benefits for human health and agriculture counterbalance costs to meet Paris Agreement pledges, NATURE COMMUNICATIONS, ISSN 2041-1723 (online), 9, 2018, p. 4939, JRC111245.*

- *Kitous, A. and Keramidas, K., Global Energy and Climate Outlook 2017: Greenhouse gas emissions and energy balances: Supplementary material to "Global Energy and Climate Outlook 2017: How climate policies improve air quality", EUR 28725 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-71653-9, doi:10.2760/034229, JRC107366.*

- *Kitous, A., Keramidas, K., Vandyck, T., Saveyn, B., Van Dingenen, R., Spadaro, J. and Holland, M., Global Energy and Climate Outlook 2017: How climate policies improve air quality, EUR 28798 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-73864-7 (online),978-92-79-75275-9 (ePub), doi:10.2760/474356 (online),10.2760/34111 (ePub), JRC107944.*

- *Vandyck T; Keramidas K; Saveyn B; Kitous A; Vrontisi Z. A global stocktake of the Paris pledges: Implications for energy systems and economy. GLOBAL ENVIRONMENTAL CHANGE-HUMAN AND POLICY DIMENSIONS 41; 2016. p. 46-63. JRC101134*

- *Vrontisi Z, Abrell J, Neuwahl F, Saveyn B, Wagner F. Economic impacts of EU clean air policies assessed in a CGE framework. ENVIRONMENTAL SCIENCE and POLICY 55 (Part 1); 2016. p. 54-64. JRC96767*

- *Kitous A, Saveyn B, Keramidas K, Vandyck T, Rey Los Santos L, Wojtowicz K. Impact of low oil prices on oil exporting countries. EUR 27909. Luxembourg (Luxembourg): Publications Office of the European Union; 2016. JRC101562*

- *Kitous A; Keramidas K; Vandyck T; Saveyn B. GECO 2016: Global Energy and Climate Outlook: Road from Paris: Impact of climate policies on global energy markets in the context of the UNFCCC Paris Agreement. EUR 27952 EN. Luxembourg (Luxembourg): Publications Office of the European Union; 2016. JRC101899*

- *Saveyn, B., Paroussos, L., Szewczyk, W., Vandyck, T., Ciscar, J.-C., Karkatsouli, P., … Regemorter, D. V. (Eds.). (2016). Economic Assessment of Climate, Energy and Air Quality Policies in the EU with the GEM-E3 Model: An Overview. The WSPC Reference on Natural Resources and Environmental Policy in the Era of Global Change, 207–245. doi:10.1142/9789813208179_0007*

- *Vrontisi Z, Kitous A, Saveyn B, Vandyck T. Impact of low oil prices on the EU economy . EUR 27537. Luxembourg (Luxembourg): Publications Office of the European Union; 2015. JRC98188*
- *Vrontisi Z, Abrell J, Neuwahl F, Saveyn B, Wagner F. Impact Assessment of European Clean Air policies in a CGE framework. European Commission; 2014. JRC92553*
- *Kitous A, Saveyn B, Gervais S, Wiesenthal T, Soria Ramirez A. ANALYSIS OF THE IRAN OIL EMBARGO. EUR 25691. Luxembourg (Luxembourg): Publications Office of the European Union; 2013. JRC77983*
- *Ciscar, J.-C., Saveyn, B., Soria, A., Szabo, L., Van Regemorter, D., & Van Ierland, T. (2013). A comparability analysis of global burden sharing GHG reduction scenarios. Energy Policy, 55, 73–81. doi:10.1016/j.enpol.2012.10.044*
- *Capros P, Van Regemorter D, Paroussos L, Karkatsoulis P, Fragkiadakis C, Tsani S, Charalampidis I, Revesz T, authors Perry M, Abrell J, Ciscar Martinez J, Pycroft J, Saveyn B, editors. GEM-E3 Model Documentation. EUR 26034. Luxembourg (Luxembourg): Publications Office of the European Union; 2013. JRC83177*
- *Ciscar Martinez J, Perry M, Pycroft J, Saveyn B, Van Regemorter D. Climate damage module of GEM-E3 model (PESETA II). European Commission; 2013. JRC78145*
- *Barrios S, Pycroft J, Saveyn B. The marginal cost of public funds in the EU: the case of labour versus green taxes. Luxembourg (Luxembourg): Publications Office of the European Union; 2013. JRC82166*
- *Ciscar Martinez J, Saveyn B, Van Regemorter D. Economic modelling of climate impacts: A partial review.. Review of Business and Economic Literature 57 (2); 2012. p. 144-156. JRC75162*
- *Maisonnave H, Pycroft J, Saveyn B, Ciscar Martinez J. Does climate policy make the EU economy more resilient to oil price rises A CGE analysis. EUR 25224 EN. Luxembourg (Luxembourg): Publications Office of the European Union; 2012. JRC68858*
- *Saveyn B, Paroussos L, Ciscar Martinez J. Economic analysis of a low carbon path to 2050: a case for China, India and Japan. ENERGY ECONOMICS 34; 2012. p. S451-S458. JRC76933*
- *Ciscar Martinez J, Saveyn B, Soria Ramirez A, Szabo L, Van Regemorter D, Van Ierland T. A Comparability Analysis of Global Burden Sharing GHG Reduction Scenarios. EUR 25222 EN. Luxembourg (Luxembourg): Publications Office of the European Union; 2012. JRC68856*
- *Maisonnave, H., Pycroft, J., Saveyn, B., & Ciscar, J.-C. (2012). Does climate policy make the EU economy more resilient to oil price rises? A CGE analysis. Energy Policy, 47, 172–179. doi:10.1016/j.enpol.2012.04.053*

- *Ciscar, J.-C., Szabó, L., van Regemorter, D., & Soria, A. (2011). The integration of PESETA sectoral economic impacts into the GEM-E3 Europe model: methodology and results. Climatic Change, 112(1), 127–142. doi:10.1007/s10584-011-0343-y*

- *Saveyn, B., Van Regemorter, D., & Ciscar, J. C. (2011). Economic analysis of the climate pledges of the Copenhagen Accord for the EU and other major countries. Energy Economics, 33, S34–S40. doi:10.1016/j.eneco.2011.07.024*

- *Ciscar Martinez J, Feyen L, Iglesias A, Szabo L, Van Regemorter D, Amelung B, Nicholls R, Watkiss P, Christensen O, Dankers R, Garrote L, M. Goodess C, Hunt A, Moreno A, Richards J, Soria Ramirez A. Physical and economic consequences of climate change in Europe. PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA 108 (7); 2011. p. 2678-2683. JRC63970*

- *Russ H, Ciscar Martinez J, Saveyn B, Soria Ramirez A, Szabo L, Van Regemorter D. Economic Assessment of Post-2012 Global Climate Policies - Analysis of Gas Greenhouse Gas Emission Reduction Scenarios with the POLES and GEM-E3 models. EUR 23768 EN. Luxembourg (Luxembourg): European Commission; 2009. JRC50307*

- *Russ H, Wiesenthal T, Van Regemorter D, Ciscar Martinez J. Global Climate Policy Scenarios for 2030 and beyond - Analysis of Greenhouse Gas Emission Reduction Pathway Scenarios with the POLES and GEM-E3 Models\r\n. EUR 23032 EN. Luxembourg (Luxembourg): OPOCE; 2007. JRC41526*

- *Russ H, Ciscar Martinez J, Szabo` L. Analysis of Post-2012 Climate Policy Scenarios with Limited Participation. EUR 21758 EN. 2005. JRC30404*

PRIMES-TREMOVE Transport Model

Fact sheet

Source: Commission modelling inventory and knowledge management system (MIDAS)

Date of Report Generation: 20/10/2020

Overview

Acronym PRIMES-TREMOVE
Full title PRIMES-TREMOVE Transport Model

Main purpose
PRIMES-TREMOVE simulates the transport modelling system and projects the evolution of the demand for passenger and freight transport by mode, energy consumption by fuel and emissions. The model is rich in the representation of policy measures and is used to assess policy impacts.

Summary
PRIMES-TREMOVE is a transport modelling system of multi-agent choices. The model has been developed by the E3MLab and is part of the PRIMES suite of models. Part of the model (i.e. the transport demand module), has been based on features of the open source TREMOVE model developed by Transport & Mobility Leuven. The model is suited for long term (up to 2050) projections in 5-year steps and covers all EU Member States and selected EFTA and candidate countries.

PRIMES-TREMOVE solves partial market equilibrium between the demand and the supply of transport services. Choices among alternative transport options and investment are represented by various agents' types, which differ in terms of their transport demand. Solving for equilibrium also involves the computation of energy consumption, emissions of pollutants and externality impacts related to the use of transportation means.

The model is used for policy formulation. Model projections include the transport demand by transport mode, technologies and fuels, including conventional and alternative types, and their penetration in various transport market segments. Model projections also include information about greenhouse gas and air pollution emissions, as well as impacts on external costs of congestion, noise and accidents. PRIMES-TREMOVE has been used for the 2011 Transport White Paper "Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system" (COM(2011) 144 final); for the "A European Strategy for low-emission mobility" (COM(2016) 501), for the 2050 Long-term Strategy (A Clean Planet for all - A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy; COM (2018) 773) and for many other policy documents and Impact Assessments.

Keywords
Transport , Energy , Environment , Climate , Climate policy , Air Pollution , transport demand , GHG emissions , technology innovation , market outlook

Model category (thematic)
Transport

Model home page
https://e3modelling.com/modelling-tools/primes-tremove

Ownership & license

Ownership
Sole copyright [3rd party]

Ownership details
The PRIMES-TREMOVE is a private model that has been developed and is maintained by E3MLab/ICCS of National Technical University of Athens and E3-Modelling SA.

Licence type
Non-Free Software licence. The license has one or more of the following restrictions: it prohibits creation of derivative works; it prohibits commercial use; it obliges to share the licensed or derivative works on the same conditions.

Details

PRIMES-TREMOVE structure and approach

The model consists of two main modules: the *transport demand allocation module* and the *technology choice and equipment operation module*. The two modules interact with each other and are solved simultaneously.

The *transport demand allocation module* simulates mobility decisions driven by macroeconomic drivers which distribute the transport activity over different transport modes and trip types, so as to calculate transport services by mode for both individuals and firms. The decision process is simulated as a utility maximisation problem under budget and other constraints for individual private passengers and as a cost minimisation problem for firms.

The *technology choice and equipment operation module* determines the mix of vehicle technologies (generally the transportation means), the operation of transport means by the trip type and fuel mix such as to meet the modal transport demand at the least cost. In the case of supply by transportation companies, the module calculates transportation tariffs (ticket prices). Consumer or firm choices at various levels of the supply module use total costs, inclusive of capital costs, or only variable costs, as appropriate. For example purchasing a new car involves total cost comparisons among alternative solutions, but the choice of the fuel type for an existing car, if that is possible, or determining the rate of use of an existing car naturally involves only variable costs. The choice of technology is generally the result of a discrete choice problem which considers relative costs which optionally include factors indicating impacts on externalities and the impacts of intangible costs (e.g. market acceptance, range anxiety).

Part of the supply of transport services is carried out by the same agent who is consuming such services; in other words, supply is split between self-supply of transport services and the purchasing of transport services from transportation companies. To self-supply the service, the consumer (individual or firm) faces both capital and variable costs, where capital costs correspond to the purchase of transportation means, whereas when purchasing transport services from transport suppliers the consumer faces only variable costs (corresponding to ticket prices). Transportation companies also face capital and variable costs. They sell their services at transport tariffs (ticket prices, etc.). Further, there is no capital rent for the self-supply of transport services and the consumer chooses between alternative self-supply solutions by comparing total costs, assuming the average cost pricing of alternative solutions.

Both the *transport demand allocation* and *technology choice and equipment operation* modules are dynamic over time, simulate capital turnover with possibility of premature replacement of equipment and keep track of equipment technology vintages.

Prices – as set by transportation companies – are based on marginal costs, which may allow for capital rents (e.g. aviation). Other transportation companies – owned by the state and subject to a

strong price regulation – apply average (instead of marginal) cost pricing rules to determine transportation tariffs. To include external costs, such as congestion, the model includes additional components in the equilibrium prices which is termed the “generalised price of transportation” and is calculated both for the self-production and for the business supply of transport services.

Computationally, the model is solved as a non-linear mixed complementarity problem. Optionally, policy targets related to externalities (or the overall efficiency or overall emissions) may be included as binding constraints; through the mixed complementarity formulation of the model, such overall constraints influence all choices in the demand and supply transport modules.

Formally, the model solves an equilibrium problem with equilibrium constraints (EPEC) simultaneously for multiple transport services and for multiple agents, some of which are individual consumers and firms, which consume or produce transport services. The EPEC formulation also includes overall constraints which represent policy targets, e.g. emissions, energy, etc., which influence both demand and supply. Solving for equilibrium also involves the computation of energy consumption, emissions of pollutants and externality impacts related to the use of transportation means.

Input and parametrization
The PRIMES-TREMOVE transport model is calibrated to 2005, 2010 and 2015 historical data.

The main data (such as activity and energy consumption) comes from EUROSTAT database and from the Statistical Pocketbook "EU transport in figures" (DG MOVE). Excise taxes are derived from DG TAXUD excise duty tables (https://ec.europa.eu/taxation_customs/tedb/splSearchForm.html;jsessionid=gDc40clH3ufxfoKOdXcM1t26oFiV84od01egfLest4uUPKZdXGiM!530641174).

Other data comes from different sources such as research projects (e.g. TRACCS project) and reports.

Main output
The PRIMES-TREMOVE model produces projections of transport activity, stock turnover of transport means, technology choice, energy consumption by fuel, greenhouse gas and air pollution emissions, and costs (including impacts on external costs of air pollution, congestion, noise and accidents). The projection includes details for a large number of transport means, technologies and fuels, including conventional and alternative types, and their penetration in various transport market segments.

Spatial - temporal extent
The output has the following spatial-temporal resolution and extent:

Parameter	Description
Spatial Extent / Country Coverage	EU27, EU27+UK and by Member State

(Spatial) resolution	Country
Temporal extent	2005 to 2050 time horizon
Temporal resolution	5-year time steps

Quality & transparency

Quality

Question	Answer	Details
Models are by definition affected by uncertainties (in input data, input parameters, scenario definitions, etc.). Have the model uncertainties been quantified? Are uncertainties accounted for in your simulations?	yes	The model accounts for the various uncertainties in specific input data assumptions by carrying out scenario analysis and modifying the values on selected or a set of input data. Such are the cases related to technology cost assumptions, GDP and fuel prices evolution and a combination of those. Scenarios analysis is also carried out on policy parameters like charges, taxation, vehicle standards, etc.
Sensitivity analysis helps identifying the uncertain inputs mostly responsible for the uncertainty in the model responses. Has the model undergone sensitivity analysis?	yes	The model has been frequently used for carrying out sensitivity analysis around specific uncertain inputs. The sensitivity analysis used in the model only considers changes in one input parameter such as fuel prices or GDP evolution.
Has the model undergone external peer review by a panel of experts, or have results been published in peer-reviewed journals?	yes	As module of the PRIMES energy system model, PRIMES-TREMOVE has been successfully peer reviewed in 2011. The model results have been communicated to the scientific audience (see list of relevant publications below). Model results have also been reviewed as part of deliverables in H2020 research projects.
Has model validation been done? Have model predictions been confronted with observed data (ex-post)?	yes	Validation consists in comparing to officially published policy indicators and on checking continuity of time series from past to future. The model includes calibration routines, which ensure that when the model runs retrospectively it replicates statistical data. With respect to future projections, validation is more complex because it relies on economic theory and practice. Academic validation is also practiced through publications subject to external peer review and comparisons to other studies and independent publications.

References related to external peer-review and publication in scientific journals:

- Capros, P., Zazias, G., Evangelopoulou, S., Kannavou, M., Fotiou, T., Siskos, P., … Sakellaris, K. (2019). Energy-system modelling of the EU strategy towards climate-neutrality. Energy Policy, 134, 110960. doi:10.1016/j.enpol.2019.110960
- Statharas, S., Moysoglou, Y., Siskos, P., Zazias, G., & Capros, P. (2019). Factors Influencing Electric Vehicle Penetration in the EU by 2030: A Model-Based Policy Assessment. Energies, 12(14), 2739. doi:10.3390/en12142739
- Siskos, P., & Moysoglou, Y. (2019). Assessing the impacts of setting CO2 emission targets on truck manufacturers: A model implementation and application for the EU. Transportation Research Part A: Policy and Practice, 125, 123–138. doi:10.1016/j.tra.2019.05.010
- Siskos, P., Zazias, G., Petropoulos, A., Evangelopoulou, S., & Capros, P. (2018). Implications of delaying transport decarbonisation in the EU: A systems analysis using the PRIMES model. Energy Policy, 121, 48–60. doi:10.1016/j.enpol.2018.06.016

- Capros, P., Kannavou, M., Evangelopoulou, S., Petropoulos, A., Siskos, P., Tasios, N., … DeVita, A. (2018). Outlook of the EU energy system up to 2050: The case of scenarios prepared for European Commission's "clean energy for all Europeans" package using the PRIMES model. Energy Strategy Reviews, 22, 255–263. doi:10.1016/j.esr.2018.06.009
- Siskos, P., Capros, P., & De Vita, A. (2015). CO 2 and energy efficiency car standards in the EU in the context of a decarbonisation strategy: A model-based policy assessment. Energy Policy, 84, 22–34. doi:10.1016/j.enpol.2015.04.024
- Capros, P., De Vita, A., Fragkos, P., Kouvaritakis, N., Paroussos, L., Fragkiadakis, K., … Siskos, P. (2015). The impact of hydrocarbon resources and GDP growth assumptions for the evolution of the EU energy system for the medium and long term. Energy Strategy Reviews, 6, 64–79. doi:10.1016/j.esr.2015.03.003

Transparency

Question	Answer	Details
Is the model underlying database (i.e. the database the model runs are based on) publicly available?	yes	Key databases upon which the model is built are publically available (e.g. EUROSTAT data on transport activity and energy balances).
Can model outputs be made publicly available?	yes	In publically available technical reports, scientific papers and research projects final reports.
Is the model transparently documented (including underlying data, assumptions and equations, architecture, results) and are these documents available to the general public?	yes	These are documented in selected publications in scientific journals and in the model documentation which is publically available.
Is the model source code publicly accessible or open for inspection?	no	

References related to documentation:

- No references provided in MIDAS

The model's policy relevance and intended role in the policy cycle

The model is designed to contribute to the following policy areas

- Climate action
- Energy
- Transport

The model is designed to contribute to the following phases of the policy cycle

- Formulation

The model's potential

The model can be used for policy formulation. Model projections include the transport demand by the transport mean, technologies and fuels, including conventional and alternative types, and their penetration in various transport market segments. It also includes details about greenhouse gases and air pollution emissions, as well as impacts on external costs of congestion, noise and accidents.

In the transport field, PRIMES-TREMOVE is suitable for modelling *soft measures* (e.g. eco-driving, deployment of Intelligent Transport Systems, labelling) *economic measures* (e.g. subsidies and taxes on fuels, vehicles, emissions; ETS for transport when linked with PRIMES; pricing of congestion and other externalities such as air pollution, accidents and noise; measures supporting R&D), *regulatory measures* (e.g. CO2 emission performance standards for new passenger cars, new light commercial vehicles and new heavy goods vehicles; EURO standards on road transport vehicles; technology standards for non-road transport technologies), *infrastructure policies for alternative fuels* (e.g. deployment of refuelling/recharging infrastructure for electricity, hydrogen, LNG, CNG). Used as a module which contributes to a broader PRIMES scenario, PRIMES-TREMOVE can show how policies and trends in the field of transport contribute to economy wide trends in energy use and emissions. Using data disaggregated per Member State, it can show differentiated trends across Member States.

The PRIMES-TREMOVE model has been used for the Impact Assessments accompanying the 2011 Transport White Paper , "Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system" (COM(2011) 144 final); for the "A European Strategy for low-emission mobility" (COM(2016) 501), for the 2050 Long-term Strategy (A Clean Planet for all - A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy; COM (2018) 773) and for many other policy documents and Impact Assessments.

PRIMES-TREMOVE can help to assess:

Pricing

- Infrastructure charging (e.g. Eurovignette) through:

    - Changing travel cost associated to specific infrastructures

- External costs charges (for all modes) through:
    - Changing travel costs of transport modes
- Public funding of transport (subsidies) through:
    - Changing travel cost of bus and rail

Taxation

- Energy taxation (identify energy and CO2 component) through: Changing fuel tax values by fuel type
- Vehicle taxation Changing through: cost of new vehicles

Regulation

- Standard - Transport safety through:
    - Reduction of accident factors
- Regulation on CO2 from road vehicles through:
    - Assumptions on CO2 emissions limits of new cars, light commercial vehicles and heavy goods vehicles are implemented
- Regulation on polluting emission from road vehicles (EURO standards) through:
    - Assumptions on polluting emissions limits of new cars and heavy goods vehicles are implemented
- Emissions standards for non-road modes (e.g. ICAO chapter 3 on aircraft emissions, Energy Efficiency Design Index for maritime, sulphur limits of marine fuels, etc.) through:
    - Assumptions on emissions limits of new trains/aircrafts, etc. are implemented; reduction of emissions factors for vessels
- Emissions Trading Scheme through:
    - Inclusion of aviation in EU ETS starting with 2012 – Changing transport costs of air transport
- Fuel quality through:
    - Changing fuel cost by fuel type

- Renewable energy directive through:
    - Mandatory fuels blending
- Clean Power for Transport andAvailability of refuelling/recharging Infrastructure through:
    - Changing parameters interpreting availability of refuelling/recharging infrastructures leading to faster penetration of alternative technologies

NOTE *The table 'Previous use of the model in ex-ante impact assessments of the European Commission' specifically reports the contributions of the model to the assessment of policy options.*

In addition, please note that the model has also been extensively used in impact assessments to contribute to the construction of the baseline as part of the modelling framework of the EU reference scenario 2016 Energy, transport and GHG emissions : trends to 2050, Luxembourg: Publications Office of the European Union, 2016, doi:10.2833/9127.

The use of the Reference Scenario is reported under 'Additional information' in the entries of the related impact assessments.

Previous use of the model in ex-ante impact assessments of the European Commission

Use of the model in ex-ante impact assessments since July 2017.

In the Year	PRIMES-TREMOVE contributed to the Impact assessment called	Led by	By providing input to the	The model was run by	Details of the contribution
2018	Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council: setting CO2 emission performance standards for new heavy duty vehicles SWD/2018/185 final	CLIMA	Baseline and assessment of policy options	*Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens*	Projections include details for a large number of transport means, technologies and fuels, and their penetration in various transport market segments. Include details about GHG and air pollution emissions, final energy demand.
2018	Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council: establishing a European Maritime Single Window environment and repealing directive 2010/65/EU SWD/2018/181 final	MOVE	Baseline and assessment of policy options	*Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens*	PRIMES-TREMOVE together with TRUST have been also used to assess the impacts of policy options on modal shift and CO2 emissions.
2018	Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council on: electronic freight transport information SWD/2018/183 final	MOVE	Baseline and assessment of policy options	*Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens*	PRIMES-TREMOVE has been used to assess the impacts of policy options on user costs, modal shift, energy use, CO2 and air pollutant emissions.
2018	Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council on: streamlining measures for advancing the realisation of the trans-European transport network SWD/2018/178 final	MOVE	Baseline only	*Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens*	The PRIMES-TREMOVE model was used to build the baseline scenario.
2018	Impact assessment accompanying the document Proposal for a Directive of the European Parliament and of the Council: amending Directive 2008/96/EC on road infrastructure safety management SWD/2018/175 final	MOVE	Baseline only	*Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens*	PRIMES-TREMOVE model has been used for the baseline scenario.

2017	Impact assessment accompanying the document Proposal for a Directive of the European Parliament and of the Council: amending Directive 2009/33/EC on the promotion of clean and energy-efficient road transport vehicles SWD/2017/0366 final	MOVE	Baseline only	*Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens*	The updated baseline was developed using the PRIMES-TREMOVE model.
2017	Impact assessment accompanying the document Proposal for a Regulation from the European Parliament and the Council on: rail passengers' rights and obligations (recast) SWD/2017/0318 final/2	MOVE	Baseline only	*Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens*	Refer to Study: EU reference scenario 2016 Energy, transport and GHG emissions : trends to 2050. Documented in: - DOI 10.2833/001137
2017	Impact assessment accompanying the document Proposal for a Directive of the European Parliament and of the Council: amending Directive 92/106/EEC on the establishment of common rules for certain types of combined transport of goods between Member States SWD/2017/0362 final	MOVE	Baseline and assessment of policy options	*Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens*	PRIMES-TREMOVE was used for the baseline and for the assessment of the environmental impacts.
2017	Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council: amending Regulation (EC) No 1073/2009 on common rules for access to the international market for coach and bus services SWD/2017/0358 final	MOVE	Baseline only	*Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens*	The baseline scenario has been developed with the PRIMES-TREMOVE model.
2017	Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council: setting emission performance standards for new passenger cars and for new light commercial vehicles as part of the Union's integrated approach to reduce CO2 emissions from light-duty vehicles and amending Regulation (EC) No 715/2007 (recast) SWD/2017/0650 final	CLIMA	Baseline and assessment of policy options	*Energy - Economy - Environment Modelling Laboratory, National Technical University of Athens*	The PRIMES-TREMOVE model is used to project the evolution of the road transport sector.

Bibliographic references

- *Capros, P., Zazias, G., Evangelopoulou, S., Kannavou, M., Fotiou, T., Siskos, P., … Sakellaris, K. (2019). Energy-system modelling of the EU strategy towards climate-neutrality. Energy Policy, 134, 110960. doi:10.1016/j.enpol.2019.110960*

- *Statharas, S., Moysoglou, Y., Siskos, P., Zazias, G., & Capros, P. (2019). Factors Influencing Electric Vehicle Penetration in the EU by 2030: A Model-Based Policy Assessment. Energies, 12(14), 2739. doi:10.3390/en12142739*

- *Siskos, P., & Moysoglou, Y. (2019). Assessing the impacts of setting CO2 emission targets on truck manufacturers: A model implementation and application for the EU. Transportation Research Part A: Policy and Practice, 125, 123–138. doi:10.1016/j.tra.2019.05.010*

- *Siskos, P., Zazias, G., Petropoulos, A., Evangelopoulou, S., & Capros, P. (2018). Implications of delaying transport decarbonisation in the EU: A systems analysis using the PRIMES model. Energy Policy, 121, 48–60. doi:10.1016/j.enpol.2018.06.016*

- *Capros, P., Kannavou, M., Evangelopoulou, S., Petropoulos, A., Siskos, P., Tasios, N., … DeVita, A. (2018). Outlook of the EU energy system up to 2050: The case of scenarios prepared for European Commission's "clean energy for all Europeans" package using the PRIMES model. Energy Strategy Reviews, 22, 255–263. doi:10.1016/j.esr.2018.06.009*

- *Siskos, P., Capros, P., & De Vita, A. (2015). CO 2 and energy efficiency car standards in the EU in the context of a decarbonisation strategy: A model-based policy assessment. Energy Policy, 84, 22–34. doi:10.1016/j.enpol.2015.04.024*

- *Capros, P., De Vita, A., Fragkos, P., Kouvaritakis, N., Paroussos, L., Fragkiadakis, K., … Siskos, P. (2015). The impact of hydrocarbon resources and GDP growth assumptions for the evolution of the EU energy system for the medium and long term. Energy Strategy Reviews, 6, 64–79. doi:10.1016/j.esr.2015.03.003*

Electronically signed on 22/10/2020 22:24 (UTC+02) in accordance with article 11 of Commission Decision C(2020) 4482