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/2018/185 final

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

Supporting model(s)

DIONE, PRIMES-TREMOVE, VECTO

Impact assessment SWD/2018/185 final

Fact sheet on model contributions

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

Date of Report Generation: 20/10/2020

Overview

Title
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

Document ID
SWD/2018/185 final

Year of publication
2018

Led by
CLIMA

Model(s) used
DIONE, PRIMES-TREMOVE, VECTO

Additional information on model use for this Impact assessment

The Baseline and policy scenarios used in this impact assessment build for most of their parts 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 PRIMES, PRIMES-TREMOVE) as it was established at the end of 2014, but additionally include a few more recently adopted policy measures and some updates in the technology costs assumptions. For details, please check the text of the impact assessment report.

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: Heavy duty vehicle CO2 emission reduction cost curves and cost assessment – enhancement of the DIONE model

Further details can be found in:

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.

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

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.

VECTO

Full title

Vehicle Energy Consumption calculation TOol

Run for this impact assessment by

European Commission

Contributed to

Problem definition

Details of the contribution

The model VECTO is the subject of this impact assessment.

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 CO_2 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 CO_2 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 CO_2 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 CO_2 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*

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*

VECTO - Vehicle Energy Consumption calculation TOol

Fact sheet

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

Date of Report Generation: 20/10/2020

Overview

Acronym VECTO
Full title Vehicle Energy Consumption calculation TOol

Main purpose
VECTO is a vehicle simulation software created to support CO2 emissions monitoring from Heavy Duty Vehicles (HDV) in Europe and serve as the official CO2 calculation tool in the certification scheme.

Summary
The Vehicle Energy Consumption calculation TOol (VECTO) is a Heavy Duty Vehicle (HDV) energy consumption simulation software developed by the European Commission for regulatory purposes. VECTO software platform consists of VECTO software and a series of other software tools developed for the needs of the HDV certification procedure. Those include VECTO-Engine, VECTO-AirDrag and VECTO-hash&sign tools which are used at various points during the certification process. VECTO software is licensed under the European Union Public Licence (EUPL). VECTO provides output values for the average of the test cycle and in 1 Hz resolution for the entire test cycle together with relevant additional simulation results (e.g. power demand of single auxiliaries, losses in transmission, total driving resistance and share of the single driving resistances).

VECTO has been introduced in May 2017 in the European vehicle type-approval system as the official tool used in Europe to certify and monitor the fuel consumption and CO2 emissions from HDV, and its use is compulsory in Europe for CO2 certification of Heavy Duty Vehicles according to 2017/2400/EU. Beyond this use in policy implementation, VECTO can be used in any other phase of the policy cycle including impact assessment studies, analysis of the likely impact of specific technologies on fuel consumption and CO2 emissions, and formulation and analysis of future policy scenarios.

Keywords
vehicle simulation , fuel consumption , CO2 emissions , heavy-duty vehicles , HDV

Model category (thematic)
Transport

Model home page
https://ec.europa.eu/clima/policies/transport/vehicles/vecto_en

Ownership & license

Ownership
Sole copyright [European Union]

Ownership details
The model was developed by Technical University of Graz and Ricardo AEA on behalf of the JRC and DG CLIMA. The Commission holds the IPR. The model is licenced under EUPL 1.2.

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

VECTO structure and approach
The VECTO vehicle simulation model is used for Heavy Duty Vehicle CO2 and fuel consumption certification in Europe.

The model needs detailed input on a large variety of vehicle subsystems, especially rolling resistance, air drag and transmission data, as well as an engine map. Generic models are available for a number of subsystems, but further development is bringing in more detail, as requested by the industry.

Given the input data for a base vehicle, VECTO is capable of simulating different vehicle configurations, allowing for a quick estimation of CO2 emissions and energy consumption from heavy duty vehicles of different characteristics. VECTO simulates CO2 emissions and fuel consumption based on vehicle longitudinal dynamics using a driver model for simulation of target speed cycles. The required load to be delivered by the internal combustion engine is calculated in 1Hz based on the driving resistances, the power losses in the drivetrain system and the power consumption of the vehicle auxiliary units. Engine speed is determined based on a gear shift model, the gear ratios and the wheel diameter. Fuel consumption and CO2 emissions are then interpolated from an engine fuel/CO2 map. The VECTO software is written in C#.

Input and parametrization
Main inputs

- Engine fuel consumption map
- Torque loss maps at the drive train
- Vehicle mass
- Vehicle road loads
- Vehicle characteristics
- Vehicle auxiliary systems

Main output
The list of output values has been defined together by the developers and industry. The model provides CO2 and fuel consumption results over official and user defined driving cycles (mission profiles). Various metrics can be calculated such as gCO2/km, gCO2/t-km, gCO2/passenger-km litres/100km, l/100passenger-km etc.

Spatial - temporal extent

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

Parameter	Description
Spatial Extent / Country Coverage	Specific driving cycle / mission profile.
(Spatial) resolution	Not relevant
Temporal extent	Simulation of HDV operation over given mission profiles and operating conditions. Usual temporal resolution 2 or 1 Hz. Seasonal variations cannot be captured.
Temporal resolution	1 Hz

Quality & transparency

Quality and reliability

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 uncertainties have been quantified by several stakeholders including heavy duty vehicle manufacturers.
Sensitivity analysis helps identifying the uncertain inputs mostly responsible for the uncertainty in the model responses. Has the model undergone sensitivity analysis?	yes	Yes the JRC has made a first sensitivity analysis, the findings are currently under publication. A limited range SA has been performed by contractors of DG Clima as part of this study: https://ec.europa.eu/clima/sites/clima/files/transport/vehicles/heavy/docs/final_report_co2_hdv_en.pdf
Has the model undergone external peer review by a panel of experts, or have results been published in peer-reviewed journals?	yes	It undergoes continuous review by industrial stakeholders who use it for certification purposes and independently by the JRC.
Has model validation been done? Have model predictions been confronted with observed data (ex-post)?	yes	Three reports have been published to date on the topic by the JRC. Validation has been done by some member states and by industrial stakeholders.

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

- Fontaras G, Grigoratos T, Savvidis D, Anagnostopoulos K, Luz R, Rexeis M, Hausberger S. An experimental evaluation of the methodology proposed for the monitoring and certification of CO2 emissions from heavy-duty vehicles in Europe. ENERGY 102; 2016. p. 354-364. JRC100358

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, the input is vehicle specific and derived during the certification process.
Can model outputs be made publicly available?	yes	Depends on who is using the model. As JRC we draft reports and papers on the simulations we run with VECTO.
Is the model transparently documented (including underlying data, assumptions and equations, architecture, results) and are these documents available to the general public?	yes	The documentation is available in the presentations available on the public VECTO website and here: M. Rexeis, M. Quaritsch, S. Hausberger et al. VECTO tool development: Completion of methodology to simulate Heavy Duty Vehicles' fuel consumption and CO2 emissions Upgrades to the existing version of VECTO and completion of certification methodology to be incorporated into a Commission legislative proposal. Specific Contract N° 34020112014/695203/SERJCLIMA.C.2 Framework contract CLIMA.C.2/FRA/2013/0007available at https://ec.europa.eu/clima/sites/clima/files/transport/vehicles/docs/sr7_lot4_final_report_en.pdf
Is the model source code publicly accessible or open for inspection?	yes	The source code, the users manual and the technical annex regarding VECTO are public by law.

References related to documentation:

- Fontaras G, Martin R, Dilara P, Hausberger S, Anagnostopoulos K. The Development of a Simulation Tool for Monitoring Heavy-Duty Vehicle CO2 Emissions and Fuel Consumption in Europe. In: 11th International Conference on Engines and Vehicles; 15 September 2013; Capri. SAE Technical Papers SAE Technical Paper 2013-24-0150; 2013. JRC84884

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
- Research and innovation

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

- Anticipation
- Formulation
- Implementation
- Evaluation

The model's potential

This model is the tool of reference for the certification of CO2 from heavy-duty vehicles. After further development it will also allow the Commission to assess the effects of new technologies. The results of this model can be used in order to estimate the effects of new technologies on the CO2 emissions and fuel consumption of heavy-duty vehicles.

VECTO has been used in impact assessment studies done by DG CLIMA on CO2 monitoring and standards.

The following kind of questions can be answered, related to Impact Subcategory Vehicle Emissions, Fuel and Energy Consumption :

- What is the impact of certain vehicle specifics on the fuel consumption and CO2 emissions of Heavy Duty Vehicles?
- Can a given technology option reduce energy/fuel consumption of Heavy Duty Vehicles by Z%? Does it increase or decrease vehicle emissions? Will the option increase/decrease energy and fuel needs/consumption?
- What is the likely performance of today's Heavy Duty Vehicle fleet with respect to energy consumption?

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	VECTO 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	Problem definition	*European Commission*	The model VECTO is the subject of this impact assessment.

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.*
- *Penedo De Sousa Marques, A., Hradec, J. and Rosenbaum, E., Baseline Assumptions in EC Impact Assessments: Significance, Analysis and Recommendations , EUR 28951 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-77153-8, doi:10.2760/982695, JRC109839.*
- *Tansini, A., Zacharof, N., Prado Rujas, I. and Fontaras, G., Analysis of VECTO data for Heavy-Duty Vehicles (HDV) CO2 emission targets, EUR 29283 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-93163-5, doi:10.2760/551250, JRC112015.*
- *Grigoratos, T., Fontaras, G., Tansini, A., Giechaskiel, B., Savvidis, D. and Ciuffo, B., Assessment of the Measurement Methodology for CO2 Emissions from Heavy Duty Buses and Coaches , EUR 29372 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-94184-9 (online), doi:10.2760/74053 (online), JRC113307.*
- *Zacharof, N., Fontaras, G., Grigoratos, T., Ciuffo, B., Savvidis, D., Delgado, O. and Rodriguez, F., Estimating the CO2 Emissions Reduction Potential of Various Technologies in European Trucks Using VECTO Simulator, In: 13th International Conference on Engines and Vehicles, 10-14 September 2017, Capri, Italy, SAE Technical Papers, 2017, ISSN 0148-7191, JRC105548.*
- *Grigoratos, T., Fontaras, G., Giechaskiel, B. and Ciuffo, B., Assessment of the monitoring methodology for CO_2 emissions from heavy duty vehicles: Pilot phase test-campaign report and analysis of the ex-post verification options, EUR 28409 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-64966-0, doi:10.2760/081827, JRC104993.*
- *Fontaras G, Grigoratos T, Savvidis D, Anagnostopoulos K, Luz R, Rexeis M, Hausberger S. An experimental evaluation of the methodology proposed for the monitoring and certification of CO2 emissions from heavy-duty vehicles in Europe. ENERGY 102; 2016. p. 354-364. JRC100358*
- *Zacharof N; Fontaras G. Report on VECTO Technology Simulation Capabilities and Future Outlook. EUR 28272 EN. Luxembourg (Luxembourg): Publications Office of the European Union; 2016. JRC103864*

- *Ciuffo B, Fontaras G, Malfettani S, Marotta A, Anagnostopoulos K, Arcidiacono V, Bonnel P, Lodi C, Pavlovic J, Perujo Mateos Del Parque A, Praksova R, Serra S, Tsiakmakis S, Van Grootveld G, Weiss M, Zacharof N. Final Report: Administrative Arrangement No. 33280/071201/2013/655699/CLIMA.C.2 between Directorate General Climate Action (DG-CLIMA) and Directorate General Joint Research Centre (DG-JRC) CO2 from road vehicles 2013-2015 . European Commission - Joint Research Centre; 2015. JRC97075*

- *Fontaras G, Anagnostopoulos K, Savvidis D, Pavret Rochefordiere C. SERVICE REQUEST n°5: Further development of VECTO (Lot-4). Ispra (Italy): European Commission; 2014. JRC94097*

- *Fontaras G, Luz R, Anagnostopoulos K, Savvidis D, Hausberger S, Rexeis M. Monitoring CO2 emissions from HDV in Europe – An Experimental Proof of Concept of the Proposed Methodological Approach. Transport and air pollution conference; Technical University of Graz - Joint Research Centre (Organiser). Graz University of Technology; 2014. JRC91415*

- *Fontaras G, Anagnostopoulos K. JRC contribution to CLIMA`s Service request 3 (SR3) for extending VECTO with Auxiliaries (HVAC, Pneumatics, Electricals). Ispra (Italy): European Commission; 2014. JRC94100*

- *Fontaras G, Martin R, Dilara P, Hausberger S, Anagnostopoulos K. The Development of a Simulation Tool for Monitoring Heavy-Duty Vehicle CO2 Emissions and Fuel Consumption in Europe. In: 11th International Conference on Engines and Vehicles; 15 September 2013; Capri. SAE Technical Papers SAE Technical Paper 2013-24-0150; 2013. JRC84884*