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PHEM

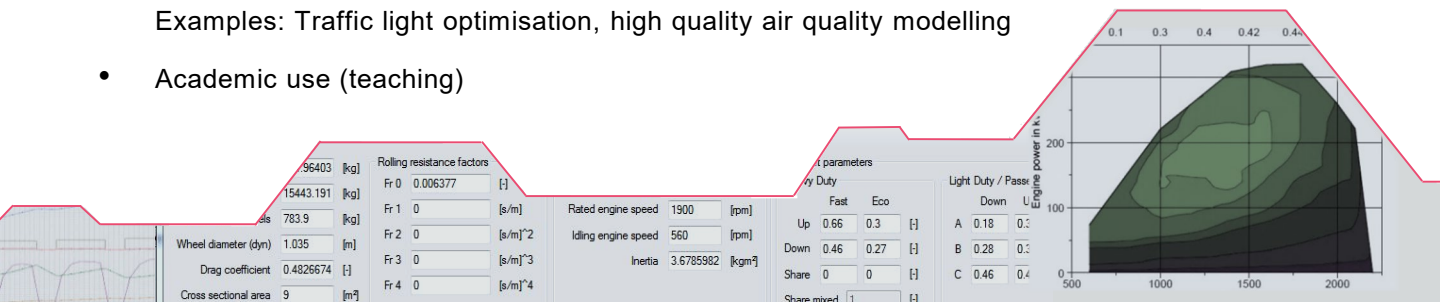
Passenger car and Heavy duty Emission Model

OVERVIEW MODEL FEATURES

- Vehicle longitudinal dynamics simulation to calculate drive power and speed in 1Hz
- Engine emission behaviour characterised by “emission maps” via engine speed and power
- Additional model elements for exhaust aftertreatment simulation (e.g. SCR, NSC), electrified powertrains (HEV, PHEV, EV) and emission behaviour in transient conditions
- Calculation of cold-start extra emissions as well as tire and brake wear PM and PN
- Evaluation of measured driving cycles with regard to savings potential (fuel and emissions)
- HBEFA “average-vehicles” are provided in the corresponding PHEM data package
- Main model output: fuel consumption, CO_2 and pollutant emissions
- Features an interface to micro-scale traffic models (e.g. VISSIM, Aimsun)

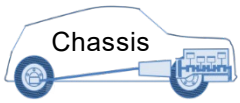
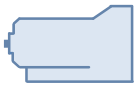
TYPICAL MODEL APPLICATIONS

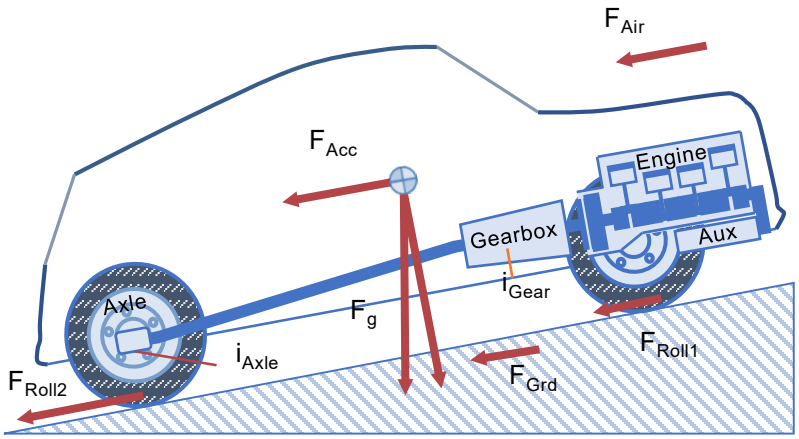
- Used for elaboration of HBEFA emission factors for passenger cars, light commercial vehicles and heavy duty vehicles. Implementation of two-wheelers in progress for HBEFA.
- Using HBEFA “average vehicles” for generation of emission factors for special local conditions (user defined data on driving cycles, road gradient, ambient conditions, special fleet mix …)
  Example: Comparison of vehicle emissions for speed limit 30 km/h vs. 50 km/h from measured velocity trajectories
- Research and engineering tool
  Example: simulation of thermal conditions in the exhaust system for layout of waste heat recovery systems
- Link with micro-scale traffic models (e.g. VISSIM, Aimsun)
  Examples: Traffic light optimisation, high quality air quality modelling
- Academic use (teaching)



PHEM SIMULATION APPROACH

VEHICLE PARAMETERS

Chassis 	C_d x A, mass, rotational inertias
Tires 	r_{dyn}, RRC
Gearbox + axle 	Loss maps i_{Gears}, i_{Axle}
Engine	P_{rated} Full load curve, emission maps, Transient parameters
Auxiliaries	Average power demand per auxiliary
Aftertreatment 	Thermal capacities Functions for conversion efficiencies



$$P_e = P_{Air} + P_{Roll} + P_{Acc} + P_{Grd} + P_{Loss} + P_{Aux}$$

For further information: www.ivt.tugraz.at/

PHEM LICENCE CONDITIONS

The “Passenger car and Heavy duty Emission Model” PHEM was developed at the Graz University of Technology (TU Graz) in cooperation with the FVT mbH. The following sections describe the conditions and the price for licences.

1. SOFTWARE

The software will be delivered as executable code including a license file to run PHEM on two computers. Following versions are available:

- **PHEM Basic:** simulation of single vehicles
- **PHEM Advance:** interface with micro traffic models and automated allocation of the vehicles to user defined shares in mileage
- **PHEM Batch:** automated simulation of lists of vehicles with a list of driving cycles, as used for the HBEFA V4

All versions of the model are compatible. They use the same simulation modules but do have adapted interfaces for the user. For details on the software please look at the user manual.

2. DATA

PHEM has a huge data base for different cars, HDV, LDV an MC from which also input files for the “average” vehicle categories were elaborated as used in the HBEFA Version 4. For the following categories data files can be delivered:

- **Passenger Cars** (diesel, gasoline, EURO 0 to EURO 6d)
- **Light Duty Vehicles** (diesel, gasoline, EURO 0 to EURO 6)
- **Heavy Duty Vehicles** (diesel, EURO 0 to EURO VI, split into weight categories)
- **Buses**
- **Coaches**
- **Motorcycles** (gasoline, EURO 0 to EURO 6, split into capacity categories)

Buying these data sets, the licensee can use the software PHEM and the data files for any national application. If the data files delivered with the software are changed by the licensee, the changes have to be mentioned in any publications related to simulation runs with changed data if the results are designated in the publication to the application of the model PHEM.

If the software PHEM and the data files shall be used by the licensee for: work for HBEFA and the ERMES group and other projects directly ordered by the European Commission, for COPERT or any task aiming at the calculation of emission factors for Austria, Germany, Switzerland or the entire EU vehicle fleet, the licensee needs the written agreement from TU Graz - Institute for Internal Combustion Engines and Thermodynamics.

OTHER CONDITIONS

- The use of the software and of the corresponding data is at licensees own risk and the software is provided on an “as is” basis and without warranty of any kind.
- TU Graz and FVT make no warranty that the software and the corresponding data will meet all of licensees requirements, that the software and the corresponding data will be error-free or bug-free and regarding the security, reliability or the performance of the software.
- Errors in the software will be corrected by TU Graz if resulting in improper results and if possible within the overall software architecture. Errors have to be documented by the user in written form in English or in German.
- Suggestions for improvements in the software and in the corresponding data are welcome. TU Graz and FVT make efforts for ongoing improvements in the model PHEM. However, no warranty is given that suggested improvements will be introduced in the model.

FVT and TU Graz own all rights, titles and interest in and to the software and the data distributed, including without limitation all intellectual property rights therein. The licensee agrees that it will not, nor will allow any third party to

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3. DOCUMENTATION AND TRAINING

The model is described in a user manual. The background of the model PHEM is published in several publications already. With this documentation users shall be able to apply PHEM without much additional support from TU Graz. If still questions arise, 10 h support via phone and/ or e-mail is included in the software costs. Additional support has to be agreed separately. Default rate is € 90,-/hour.

4. COSTS exkl. VAT

Software for 2 years licence (1),(2)	
PHEM Basic	€ 2.750,-
Option Batch functions	€ 210,-
Option Advance functions (vehicle fleet calculation)	€ 1.220,-
Option PHEM Hybrid and EV	€ 1.760,-
Option Non-Exhaust emission calculation	€ 700,-
Option Eco-Drive rating subroutine	€ 1.200,-
Optional more than 2 licence files, per additional PC	*€ 220,-*
Data Packs	
Passenger cars	€ 2.600,-
LDV	€ 1.100,-
HDV	€ 2.700,-
MC	€ 825,-
Training and support (10 hours)	€ 935,-
Total Package PHEM- Advance incl. support without options	***€ 16.000,-***

(1) Within these 2 years updates of the software will be supplied for free. Any further 2 years extension of the licence can be gained for 50% of the regular licence fee (e.g. € 1375,- for PHEM Basic at the cost structure shown above).

(2) An annual license can be purchased at a 35% discount.

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