Heavy-duty hybrids working group

Bernardo MARTÍNEZ
Automotive Industry Unit
bernardo.martinez@ec.europa.eu

UNECE Regulatory framework

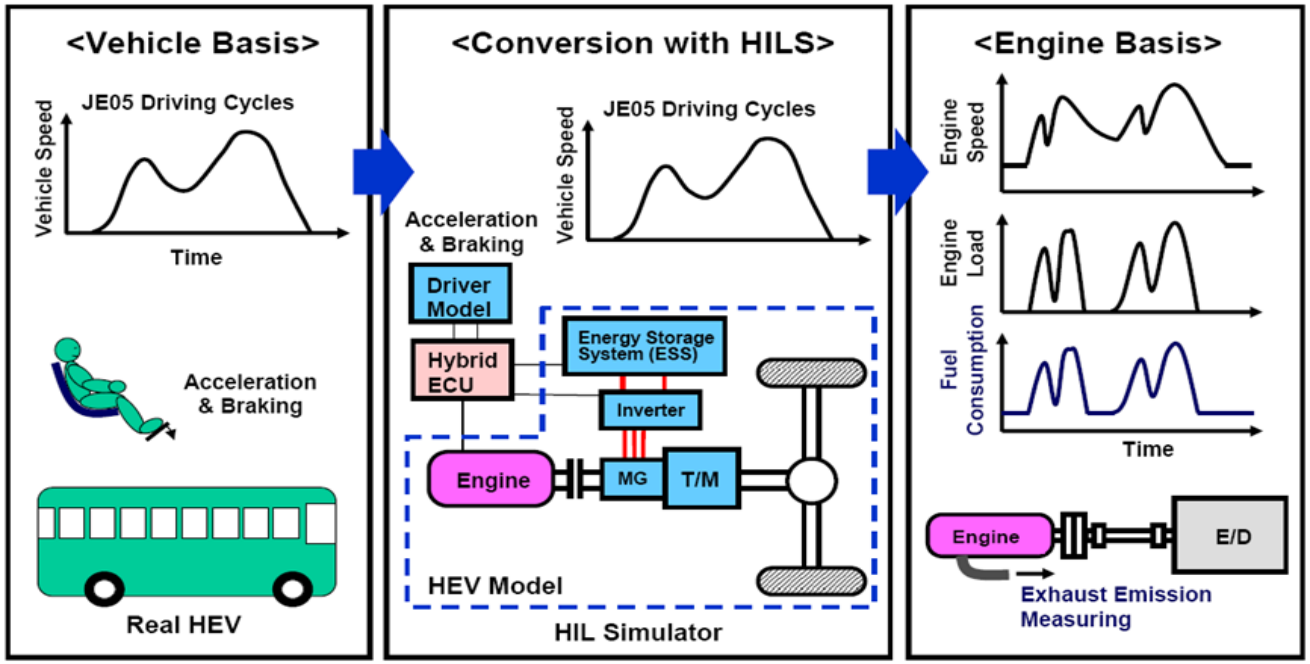
- **General purpose**
  - *Setting harmonized standards for vehicle components and systems at worldwide level*
  - *Reduction of burden to international trade*
- **1958 Agreement**
  - *Harmonization of administrative and technical requirements for **type-approval** of components and systems*
  - *Regulations apply entirely*
  - *Legal instrument: UNECE Regulations (140)*
- **1998 Agreement**
  - *Harmonization of technical requirements, but not type-approval*
  - *Contracting Parties may apply a specific Global Technical Regulation (GTR) totally or partially*
  - *Legal instrument: Global Technical Regulations (13)*

Informal group on heavy-duty hybrids

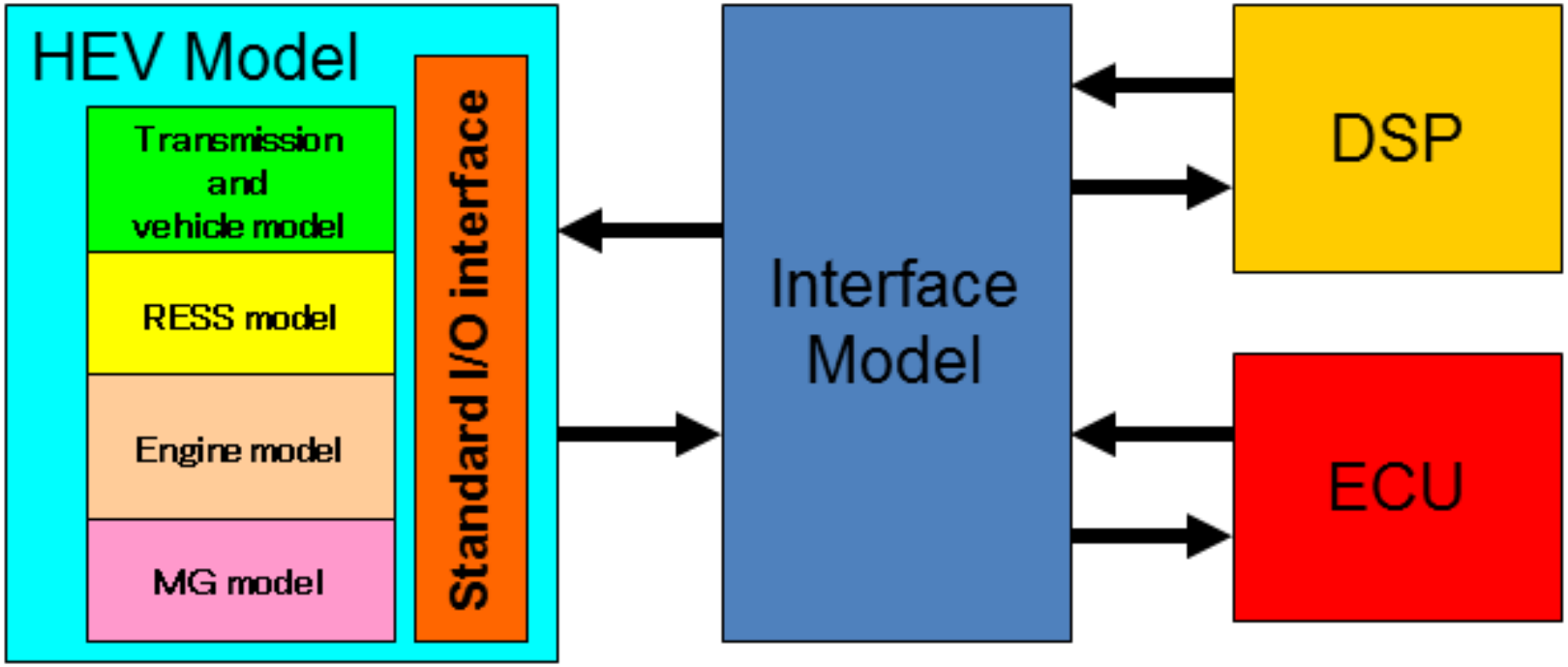
- UNECE 1998 Agreement
- Participants: Japan, European Union, USA-EPA, Environment Canada… and private stakeholders
- Target: to develop a procedure for the determination of pollutants in hybrid heavy-duty vehicles
- Legal format: Annex 8 to Global Technical Regulation No 4
- Foreseen date of adoption: November 2014
- European Commission has already contributed with 440,000 $

HILS Methodology (I)

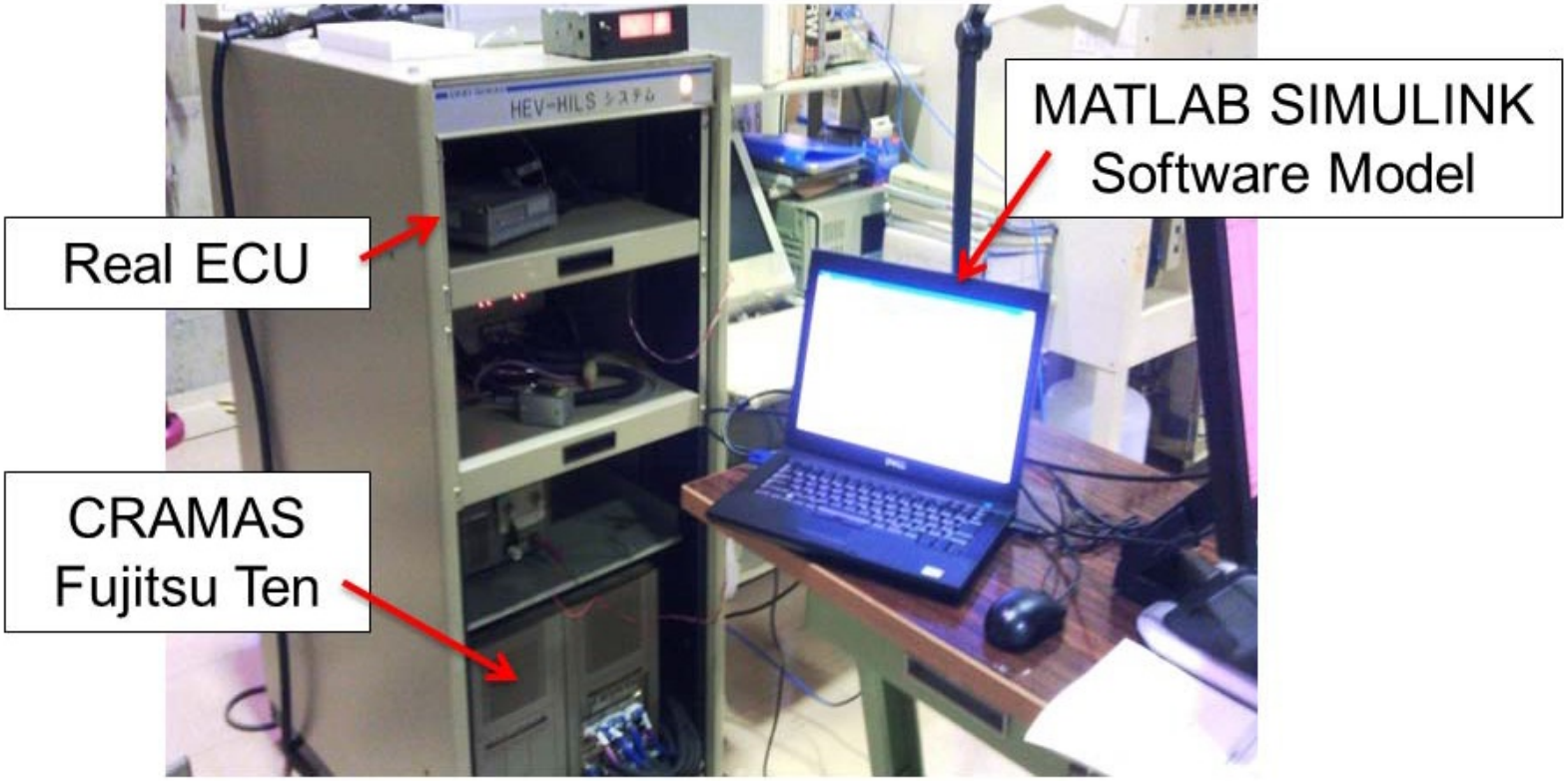
- Methodology: hardware in-the-loop (HILS) simulation
- First used in Japanese legislation



HILS Methodology (II)

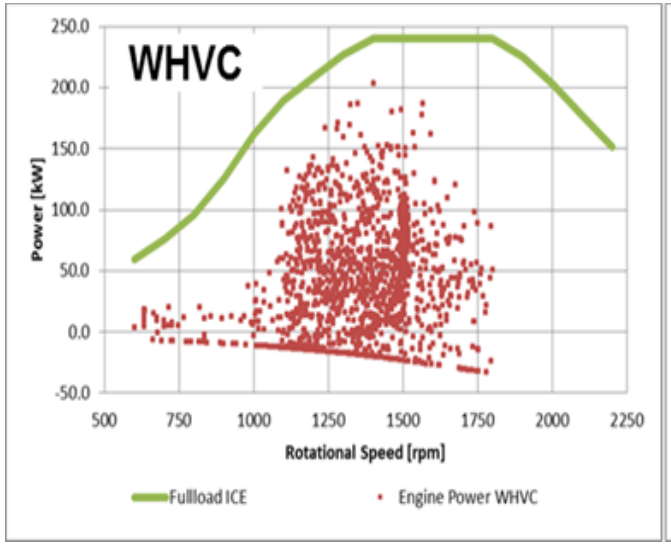


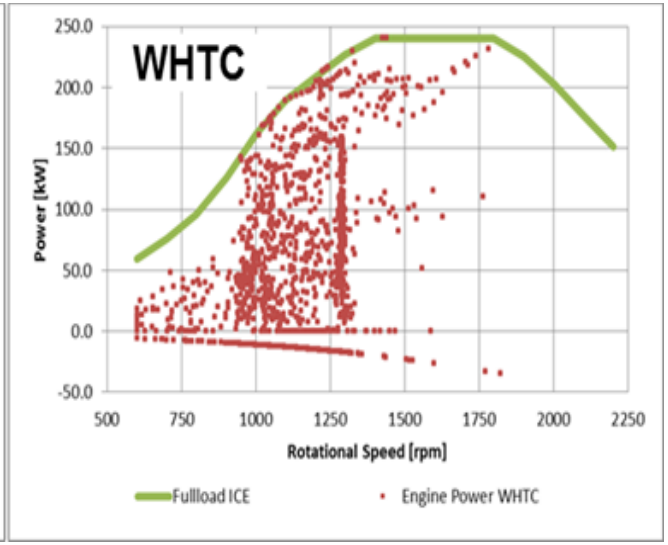
HILS Methodology (III)



Vehicle based/engine based

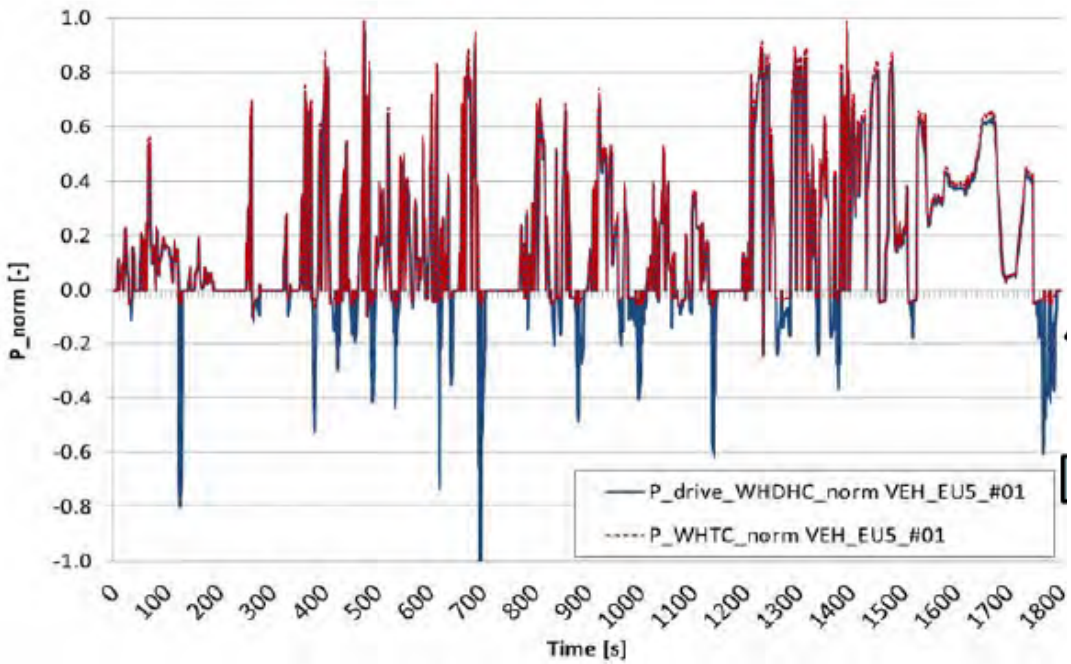
- Implement both vehicle based and engine based methodology





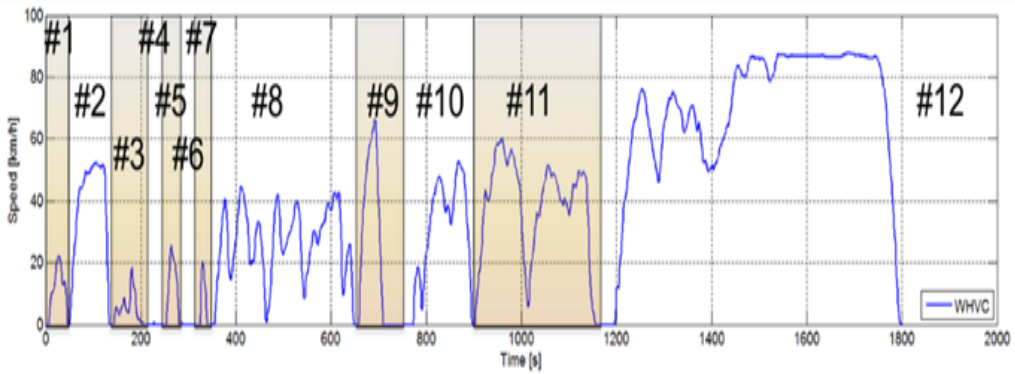
Driving cycle: WHDHC

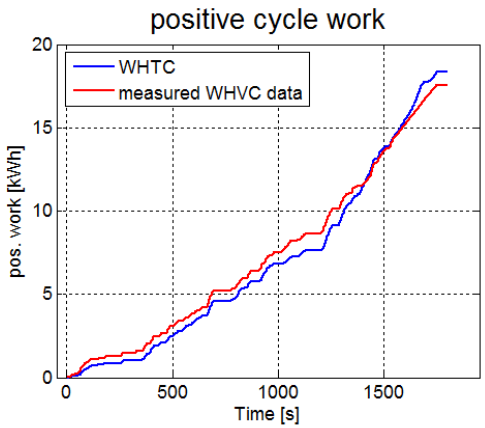
- WHDHC departs from WHTC, but adds the negative power recovered by the powertrain

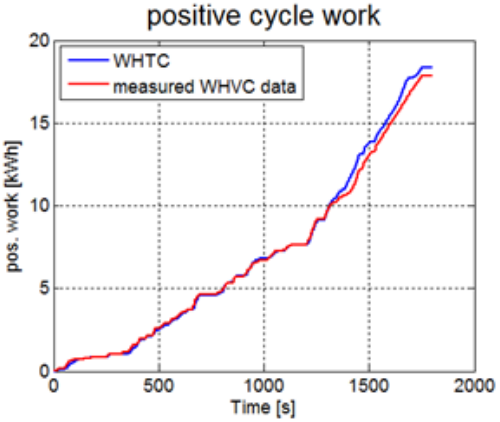


Road gradients

- Approach: Work WHVC = Work WHTC at the end of each cycle →Constant slope
- Problem: still very different works in small Δt leads to different emission results
- Solution: splitting WHVC into 12 sections and calculating average road gradient for each section







Other inputs needed for HILS

- Driver model for WHDHC
- Engine model
- RESS model
- Interface model
- Library of electric and non-electric components
- Development of test procedures (RESS, electric motor…)

CO_2 emissions. VECTO

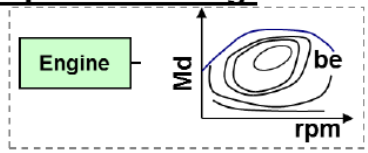
$$Pe = P_{roll.} + P_{air} + P_{acc} + P_{grad} + P_{tr.} + P_{aux} + P_{cons.}$$

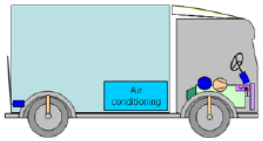
$$n = (v \times 60 \times I_{axis} \times I_{gear}) / (d \times \pi)$$

Driver model

Fuel cons., CO_2

Component testing:





Gear box, axis:
transmission, η=F(…)

Auxiliaries
duty cycle, η=F(…)

Fuel consumption map:
a) steady state + WHTC correction factors
measured on engine test bed (for engine families)

Driving resistances, options:
a) constant speed with torque measurement
b) coast down tests

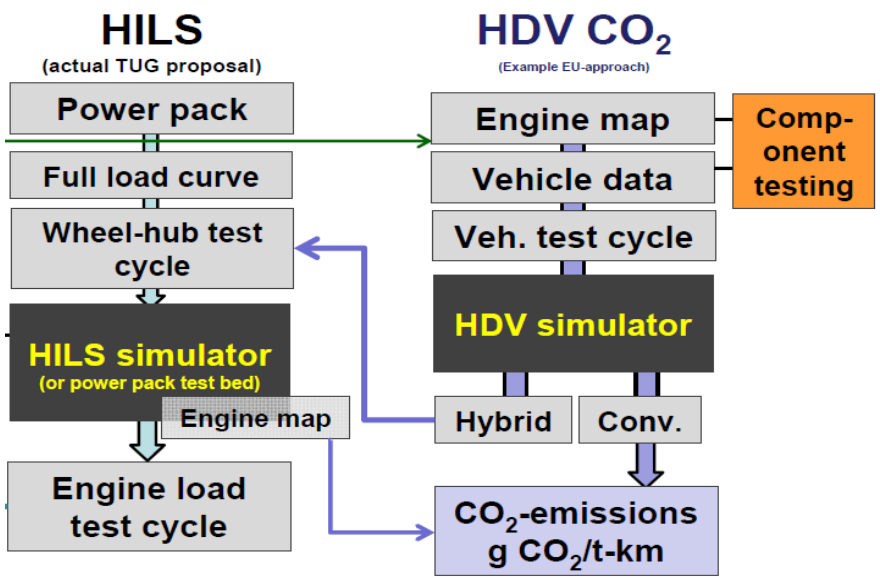
Influence from different tire models: resistance values adapted to EC No 1222/2009 (apply absolute value or Δ)

Transmission ratios, transmission losses
OEM specific maps and default values

Power demand from engine from
a) generic P_e for different technologies
b) detailed simulation

VECTO and HILS

- CO_2 is not included in the GTR
- However, it is important that information coming from CO_2 simulation tools can be used as input in HILS
- Interaction VECTO/HILS
  - *VECTO provides powertrain power and rpm (instead of WHDHC)*
  - *HILS calculates*
    - Conventional engine torque and rpm
    - Fuel consumption (interpolated from engine map)



Next steps

- Validation phase with real vehicles (Volvo, Iveco, MAN)

- Editorial work, to be finished in June 2014
- GTR to be adopted at the end of 2014
- Enactment in European legislation